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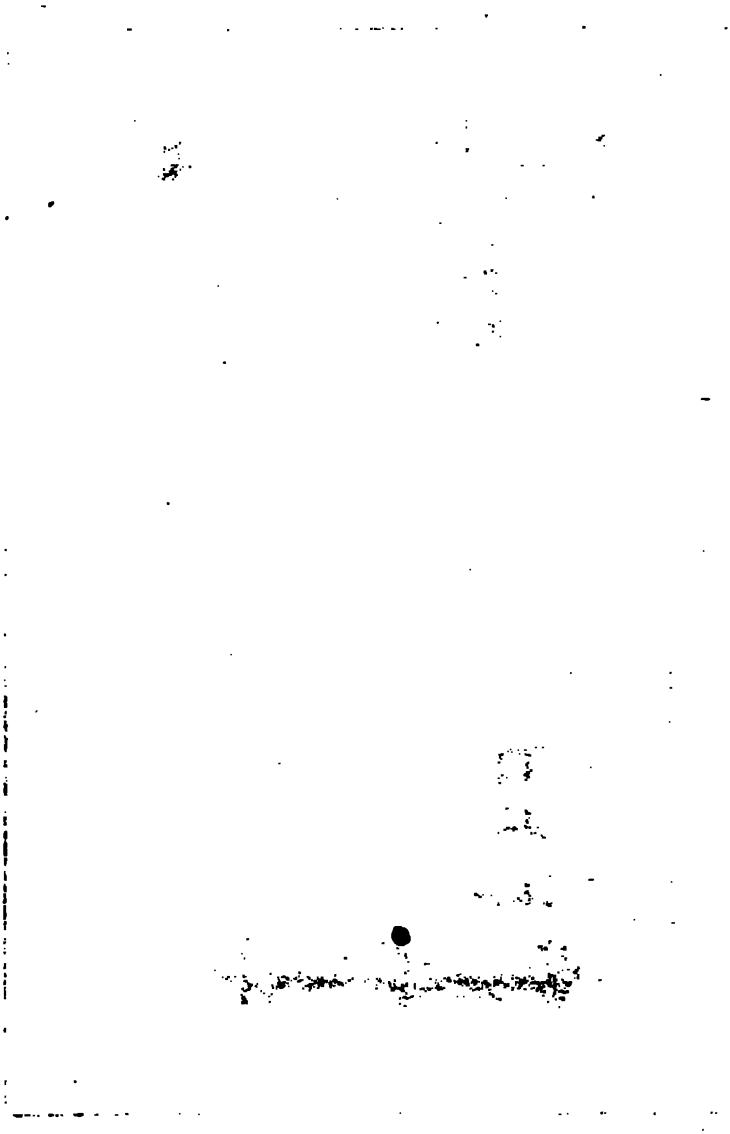
MANUAL

OF

HYPODERMIC MEDICATION.



MANUAL

OF

HYPODERMIC MEDICATION.

BY

ROBERTS BARTHOLOW, A.M., M.D.,

Professor of Materia Medica and Therapeutics in the Medical College of Ohio; Lecturer on Clinical Medicine and Physician to the Hospital of the Good Samaritan, etc., etc.

SECOND EDITION, REVISED AND ENLARGED.

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Dedicated

TO

ANDREW HULL BAKER, A.M.,

PRESIDENT OF CALVERT COLLEGE, MARYLAND,

BY HIS OBLIGED FRIEND

AND

FORMER PUPIL,

THE AUTHOR.

Je pense même, à raison de ces circonstances, que l'absorption sous-cutanée, qui n'a été employée jusqu'ici sur l'homme que par exception, devra devenir méthode générale pour l'administration de tous les médicaments énergiques, et à l'état de pureté.

Bernard.

Who that has suffered from a painful local affection can think of the alleviation of his sufferings which follows from the subcutaneous injections of an anodyne without gratitude?

Sir W. Jenner.

Die neueste Zeit, mehr und mehr einer nicht skeptischen aber rationell critischen Auffassung in therapeutischen Dingen zuneigend, hat diesen gewaltigen Apparat pharmaceutischer und dynamischer Mittel grossentheils über Bord geworfen, und beschränkt sich auf wenige, aber in eminenter Weise bewährte, locale Methoden. Dieser glückliche Uemschwung knüpft sich zum Theil an die Einführung der *hypodermatischen Injectionen*, welche die symptomatische Behandlung der Neuralgien ausserordentlich vereinfacht und vervollkommnet, die meisten älteren Verfahren ersetzt und überflüssig gemacht haben.

Eulenberg.

PREFACE

TO THE SECOND EDITION.

This edition is not a mere reprint of the first. Numerous and important additions have been made in various parts of the work. I have sought to incorporate every real improvement in hypodermic medication which has been announced since the appearance of the first edition. Much has been proposed that does not appear to me to be of permanent value, and hence I have omitted it, in conformity with my original design of keeping on the strictly practical side of my subject. Whilst I have omitted much that seemed wanting in the essential quality of utility, I have not felt at liberty to reject from consideration any remedy, a knowledge of whose uses might aid the physician in an emergency.

Now that the first enthusiasm which attended the introduction of this method has died away, we are in a position to estimate accurately its true merit. It is gratifying to me to observe that the judgments pro-

nounced in the first edition, in regard to the various agents employed in this way, have been confirmed by a larger personal experience and by the general voice of the medical profession. The hypodermic method is, certainly, a very important addition to our resources, and no physician can be considered as doing justice to his *clientèle* who does not give them the advantage, in suitable cases, of its great curative value.

In conclusion, I have to express my obligations to the reviewers for their very favorable notices of the first edition, and to the medical profession for the estimate which they have placed on my labors.

R. B.

27 West 8th Street,
Cincinnati.

PREFACE

TO THE FIRST EDITION.

As a teacher of Therapeutics, and as a practitioner, it has frequently been brought to my notice that the information existing in our language on the subject of hypodermic medication is exceedingly meagre. I have been urged by students and practitioners to prepare a convenient manual, to embody in small compass what is really known of value on this subject. This little work is the result.

Those who do me the honor to read my book will find that I have drawn largely upon my personal experience in the use of the hypodermic method. This fact, together with the necessity I was under not to enlarge my work beyond the boundaries of a "manual," will, I trust, excuse the apparent dogmatism of my statements. As, however, the experience and observation of one individual, how great soever may have been his opportunities, must necessarily, in so extensive and important a subject, be incomplete, I have

not neglected the contributions of English, French, and German physicians to this department of practical medicine.

I am indebted to the present resident physicians of the Good Samaritan Hospital for important aid. Drs. De Courcey and Rutter, with a scientific zeal which does them honor, submitted themselves to experiments in order to elucidate some important points in the physiological action of morphia and atropia. Dr. Galbraith made and recorded the observations.

Dr. J. S. Unzicker, of this city, a very capable physician and pharmaceutist, has placed me under obligations for numerous careful experiments, to determine what agent, if any, is best suited to prevent change in solutions prepared for hypodermic use.

R. B.

CINCINNATI, OHIO.

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MANUAL

OF

HYPODERMIC MEDICATION.

PART I.

History, Technology, and General Therapeutics.

I.

HISTORY.

THERE are two important epochs in the history of hypodermic medication:

1. The discovery of the practicability and utility of introducing medicines under the skin for the relief of local pain.

2. The subsequent demonstration that the physiological and therapeutical effects of medicines thus administered are procured through the agency of the blood, and that "localization" of the injection is not necessary.

We are indebted for the first discovery to Dr. Alexander Wood, of Edinburgh, and for the second to Mr. Charles Hunter, of London.

Dr. Wood ascertained, in 1843, that a solution of morphia injected under the skin, in the vicinity of a painful part, afforded remarkable relief to the pain.

His first publication on the subject was made in 1855, in the "Edinburgh Medical and Surgical Journal." The prior claims of Dr. Wood have been disputed by Mr. Rynd, of Dublin, for himself, and by Dr. Sieveking, of London, for Kurzak, of Vienna.* Mr. Rynd affirms that "the subcutaneous injection of medicinal substances, to combat neuralgia, was first used by himself in Meath Hospital, in 1844." It appears, however, that Dr. Wood's method was known and practiced in Edinburgh as early as 1843. Dr. Sieveking asserts that "Dr. Kurzak, of Vienna, was the first to employ the subcutaneous or hypodermic method, which was then largely used by Dr. Wood, of Edinburgh." If this statement be correct, it is not a little remarkable that the German writers on this subject do not advance the claims of Dr. Kurzak to priority of discovery. I am unable to find in the works of Erlenmeyer,† Lorent,‡ and Eulenberg,§ any mention of Kurzak's claims; on the contrary, these authorities award to Dr. Wood the honorable distinction of being the author of the hypodermic method.

Although the remote or systemic effects produced by subcutaneous injections were observed by Dr. Wood, he nevertheless attributed the curative power to the

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* Lancet, 1861, vol. i. p. 309.

† Die subcutanen Injectionen der Arzneimittel, von Dr. A. Erlenmeyer. Neuwied und Leipzig, 1866. Dritte Auflage, p. 1.

‡ Die hypodermatischen Injectionen nach clinischen Erfahrungen, von Dr. E. Lorent, in Bremen. Leipzig, 1865, p. 1.

§ Die hypodermatische Injection der Arzneimittel, etc., von Dr. Albert Eulenberg. Berlin, 1867, p. 10.

local action of the substance injected. "The local effect depends," he informs us, "much upon the affinity between the particular medicine administered and the tissue to which it is applied." In accordance with this view of the *modus operandi*, he directs that "the instrument is not to be put into the place where the patient complains of pain, but into the spot where you find you can awaken the pain on pressure,"—the painful points of Valleix. That Dr. Wood was not unobservant of the remote or systemic effect of subcutaneous injections is evident in the following remarks:

"It is truly astonishing how rapidly it affects the system. If you throw in a large quantity (of morphia), you will see the eyes immediately injected and the patient narcotized, and in a few minutes afterward you will see him in a profound sleep.".

It was reserved for Mr. Charles Hunter to demonstrate the important fact that the application of the injection to the painful points, as contended for by Wood, was really unnecessary, and that equally good effects followed the introduction of the injection into a distant part. Mr. Hunter's first paper appeared in 1859, and was entitled "Experiments relative to the Hypodermic Treatment of Disease." These experiments, made on animals, demonstrated that hypodermic injections "acted by absorption; that they acted quicker than by the endermic method, or than stomachic doses; that they acted more effectually; and that a small injected dose was equivalent to a much larger one by the stomach." Mr. Hunter was permitted to use the method of Wood on two patients afflicted with neuralgia, in care of Dr. Pittman in St. George's Hos-

pital. As "both had abscess in the neuralgic site, from the continuance of the localization," the point of introduction of the injection was varied, and it was found—"First, that in neuralgia equal benefit followed distant injection of the cellular tissue as followed the injection of the neuralgic site; secondly, that localization was not necessary to benefit a given part; and thirdly, that for certain reasons it was better not to localize—the chief being: 1, The infliction of unnecessary pain; 2, the almost certain risk of irritating, thickening, or inducing matter in the part from repetition; and 3, it became evident that a large class of neuralgia would be excluded from this treatment if it was necessary to inject the neuralgic site."

Great praise must be awarded Mr. Hunter for his success in demonstrating these important conclusions, and for popularizing his method. His industry in collecting facts and presenting them to the profession was indefatigable. His views were perseveringly advanced, —not always in very correct or elegant English, as the reader will observe,—but with an intelligent appreciation of the nature and importance of his facts. He read papers before societies; he published articles in the "Medical Mirror," "Lancet," "Medical Times and Gazette," and "British and Foreign Medico-Chirurgical Review;" he issued a pamphlet* containing all of his previous papers and some additional facts, and he enlisted, by personal effort, many of the physi-

* On the Speedy Relief of Pain and other Nervous Affections by means of the Hypodermic Method. Churchill, London, 1865.

cians and surgeons of London in a trial of the new therapeutical expedient.

It was thus, chiefly through the efforts of Mr. Hunter, that the method of Wood, previously confined to Edinburgh and to Dublin, became naturalized in England. Mr. Hunter's papers in the "Medical Times and Gazette" attracted the attention of Courty, of Montpellier, and Béhier, of Paris, who popularized the new method in France. It was soon after tried and reported upon favorably by Scanzoni, of Wurtzburg; Oppolzer, of Vienna; Graefe, of Berlin, and numerous other eminent authorities on the Continent. In 1865 a small treatise, by Dr. Lorent, of Bremen, appeared at Leipsic. A monograph, by Dr. Erlenmeyer, passed to the third edition in 1866. In 1867 the second edition of the elaborate work of Dr. Albert Eulenberg was published in Berlin. Dr. Eulenberg gives a list of two hundred and twenty articles and essays in various languages, but chiefly in German, which appeared on this subject from 1855 to the date of publication of the second edition of his work. From these facts may be seen the extraordinary extension which has been given to this method of treatment on the Continent.

The method of Wood, as illustrated by Hunter, met with a more favorable reception on the Continent than in the country of its origin. According to Dr. Anstie,* "it is still very much unappreciated" in England. It is true that the principal English physicians and surgeons think highly of the method, and now employ it largely, but, as Dr. Anstie informs us, there are "prac-

* The Practitioner, July, 1868.

titioners who will not admit that there *can* be any particular advantage in it which the old way of giving medicines does not offer."

The hypodermic method, soon after its publication by Wood, was introduced into the United States. Dr. Fordyce Barker, of New York, whilst in Edinburgh in 1856, was presented by Prof. Simpson with a hypodermic syringe. Soon after his return home, in May, 1856, he used this instrument, and was, consequently, the first in this country to practice the method of Wood. Prof. Barker's syringe was the model from which Tieman's instruments were made. In August, 1857, the late Prof. George T. Elliot published some observations on the hypodermic method. It thus appears that the new mode of using medicines was known and employed in New York when Dr. Ruppaner's articles appeared in 1860 in the "Boston Medical and Surgical Journal."

Not only was the hypodermic method as taught by Wood early naturalized in the United States, but we have data for asserting that it was practiced in New York before Wood made public his discovery, or before the earliest date assigned by Mr. Rynd, of Dublin, for his use in this way of remedial agents. Dr. Isaac E. Taylor, in a communication to the "New York Medical Gazette"* shows that Dr. Washington and he used practically the same method in the New York City Dispensary so long ago as 1839. The idea was suggested to them by the results of Lafargue's method of inoculation. Instead, however, of inserting the solid

* April 23, 1870.

medicament by means of a grooved needle, as was Lafargue's practice, these gentlemen punctured the skin with a lancet, and by means of an Anel's syringe threw a solution of the medicine under the skin. This mode of operating was the same practically as that suggested and used by Wood in 1855.

When the first edition of this work was published (1869), I was not then aware of the above facts in regard to the introduction of the hypodermic method in this country. It affords me sincere pleasure to attribute to my own countrymen the credit to which they are justly entitled.

II.

TECHNOLOGY.

Mr. Hunter proposed the term *hypodermic* in 1859, to make the terminology uniform with that already in use. The word is compounded of two Greek words, ὑπο, *under*, and δερμα, *the true skin*. By this method, then, the medicine is introduced not *into*, but *under*, the true skin, into the subcutaneous areolar tissue. This does not include the method of inoculation as practiced by Lafargue, nor the injection of irritants into diseased tissues, as proposed by Luton* and further illustrated by Bertin.† The method of Luton has, however, sufficiently close relationship with the hypodermic method, and possesses of itself sufficient value, to justify me devoting a short chapter to it.

The subcutaneous method proper consists in:

1st. The medicine in a state of solution.

2d. An instrument for injecting the solution into the subcutaneous areolar tissue.

The Solution.—A medicine employed for hypodermic use should be capable of perfect solution in the vehicle, which is usually distilled water. Particles of medicine undissolved are not only not in a condition to be readily absorbed, but act as irritants to the tissue, producing inflammation and abscess.

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* Archives Générales de Médecine, Oct. 1863.

† Ibid., Avril, 1868, p. 444.

The solution should be free from dirt or foreign matter of any description.

The solution should be neutral, or, at least, without decided acid or alkaline property.

Any substance which will coagulate the blood, or produce violent irritation, is unfit for hypodermic use.

A solution, even of a neutral substance, should not be too concentrated. Pure distilled water is entirely harmless, and the quantity of fluid injected is, within certain limits, a matter of indifference, provided suitable care be used in selecting the site and in injecting. Concentrated solutions, *cæteris paribus*, are more apt to produce local irritation than dilute solutions. Moreover, if the solution of a powerful alkaloid be very concentrated, a drop too much injected may produce dangerous symptoms. In ordinary syringes, a few drops remain at the bottom of the cylinder and in the needle; hence it is difficult, in using a very concentrated solution, to inject the precise amount desired, or, indeed, to approximate to it very closely.

Solutions of alkaloids too long kept become unfit for hypodermic use, by reason of the development in them of a *penicillum*. This organism grows at the expense of the alkaloid, and hence the solutions diminish in strength as the parasite develops. I have tested the utility of the various agents which may be employed to prevent the development of this penicillum, but have not arrived at a satisfactory result. Carbolic acid, alcohol, alum, and acetic acid, unless added to the solution in quantity sufficient to prove irritant, have not succeeded, after a sufficiently prolonged trial. The mineral acids are effective, but they confer such

irritant properties on the solution as to render its use very painful, as well as injurious. The proper method is to prepare fresh solutions as often as may be necessary, and in such quantities as the exigencies of practice may require.

In consequence of the difficulty experienced in keeping without change a solution of morphia, I now prepare it at the time of administration by dissolving a powder of definite strength in clean water. This plan will answer with morphia and a combination of morphia and atropia, but is impracticable with atropia, strychnia, ergotin, and some other agents.

I cannot too strongly urge upon the practitioner the expediency of preparing the solutions himself. The *material* required is not expensive, the processes are simple, and the confidence which comes of personal knowledge of the accuracy in the proportions is of advantage in handling the remedy. The apparatus required for this purpose consists of the following articles:

A fine grain druggist's balance.

A small glass or wedgwood mortar.

A small glass funnel.

Fine Swedish filtering paper.

Pure distilled water.

The medicine, solution of which is to be made, is to be finely triturated in the mortar, and the distilled water gradually added, with continuous stirring. When the solution is made, or before being used, it should be passed through the filter. Before the filter is used for purifying the solution, distilled water should be passed through it, to carry off loose particles of paper and

dirt which may have collected in the funnel. When prepared, the solution should be preserved in carefully stoppered vials. Stoppers of cork are unsuitable, owing to the friable nature of that material.

The practitioner should provide himself with ounce vials, having ground-glass stoppers, for containing the solutions ordinarily in use. They should be carefully labeled with name of alkaloid, the quantity to the ounce, and the proper dose.

THE INSTRUMENT.—The instrument for introducing the solution under the skin consists of a syringe, the nozzle of which is a perforated needle. The syringes first employed were crude instruments. Not being provided with a needle point, a preliminary incision through the skin was necessary in order to introduce the canula. (Instrument of Wood, and the Pravaz syringe.) Mr. Rynd, of Dublin, invented a complicated apparatus for introducing the solution under the skin, the fluid flowing out by the force of gravity. Mr. Hunter's syringe is thus described by himself: "The barrel is of glass with silver fittings, and contains a piston which works by a screw-rod, each half turn of which expels half a minim as a fine drop at the end of the pipe. Two pipes belong to each syringe, the one larger and stronger than the other. . . . The smaller pipe will be found the best for general use; it screws on and off the barrel at pleasure, and is made of silver with a hardened gold point. The point is sharp like a needle, and perforated on one side by an oblique opening."

The syringe of Pravaz, as modified by Béhier, is

much used in France. This is very similar in construction to Mr. Hunter's; it is of glass; the piston works with a screw, and the needle is attached by a screw to the barrel. The syringe of Mathieu, known as the "decimal hypodermic syringe," and graduated according to the French metrical system, is also a modification of that of Pravaz. The instrument of Lüer, which is most popular in Germany (Eulenberg), is graduated on the flat side of the semi-cylindrical piston-rod, and has a set screw, which can be used or not. The needle fits accurately by a socket-joint, without being screwed on, and has a lancet-shaped point, slightly concave on its perforated side to facilitate transfixing the skin. The Committee on Hypodermic Medication of the Medico-Chirurgical Society* recommended Coxeter's, Whicker and Blaise's, and Weiss's syringes. I am familiar with the instrument of Weiss only. This has a glass cylinder, screw-piston, is graduated, and has a capacity of thirty minims. Dr. Anstie thinks "the ideal syringe, perhaps, is a Coxeter, with the addition of a screw-joint, by which the barrel can be removed and refilled without withdrawing the canula from the skin."

In this country a modification of the Pravaz instrument, imported from France, is found in the shops. It has a glass barrel, graduated, and having a capacity of thirty minims. The piston works, with or without a screw, by means of an auxiliary screw attached, not to the mountings, but to the piston itself. It contains two gold-plated needles, differing in size, and they fit

* Medico-Chirurgical Transactions, vol. l. p. 564.

to the barrel accurately by a socket-joint, and do not screw on. Although any of these instruments may perform, more or less satisfactorily, the work required of them, they do not equal, in the judgment of the author, the instrument to be presently described. There are two strong objections to an instrument of glass.

The mountings work loose and readily give way, unless connected by lateral supports, as in the Charrière syringe.

The glass cylinder breaks easily, especially if graduated.

The advantages of a glass instrument are these:

The cylinder may be graduated.

The contents are visible to the eye.

Excellent glass instruments are now made. The cylinder is encased with metal, except the graduated part. The mountings of the cylinder, being connected with the metal, do not work loose and give way. Of course, even in these instruments fracture of the glass cylinder may readily occur.

Cheap instruments of hard rubber are also in use. They quickly get out of order, and are much inferior in construction to the fine English, French, and German syringes mentioned above. Nevertheless, a hard rubber syringe may be preferred for the injection of certain minerals.

After considerable experience and no little vexation in the use of various kinds of instruments, I do not hesitate to declare my preference for the silver hypodermic syringe. It is made of pure silver, and has a capacity of thirty minims. It contains two silver

needles of different sizes, and also a trocar, which screw on to the barrel. The needles are somewhat lancet-shaped, and readily perforate the skin. The piston does not work with a screw; it is packed with leather, and accurately fits the barrel. The lower extremity of the piston is filled in with a silver plate, which closely adapts itself to the bottom of the cylinder, in order to insure the expulsion of all the fluid. The piston-rod may be graduated, but I prefer to use a minim-glass. The piston of this instrument works so accurately that every drop in the minim-glass may be drawn up into the barrel by aspiration, and all may be injected except the small portion which remains in the needle.

The advantages of the silver hypodermic syringe are these:

It is not readily broken.

It will wear indefinitely.

It performs the required work in a satisfactory manner.

Nothing is more certain, however, than that carelessness will render useless the best instrument. Some details, therefore, with regard to the care of a hypodermic syringe will not be considered superfluous.

The leather packing must be kept well oiled, and so spread out that when the piston is forced down, the orifice of exit being closed, air cannot pass the piston. If the leather be permitted to become dry and shrink, the instrument will be unfit for use, and possibly at a time when its use might be urgently demanded. The cylinder should be frequently washed out with pure water, to insure that it is free from undissolved medi-

cine and particles of dirt. The needles must be wiped dry after use, and the fine wire with which they are accompanied must be introduced. If long disused, the needles rust and become closed. There should accompany each hypodermic syringe a *rimmer*, an instrument for cleaning out the needles when obstructed. The possibility of communicating disease by inoculation of specific matter should not be overlooked.

There are several methods by which the hypodermic syringe may be charged with the required dose of the solution. The fluid may be drawn up into the barrel by aspiration, the cap of the barrel may be unscrewed, the piston removed, and the solution poured into the barrel. The former is more convenient. If air enter when the fluid is being drawn up, it may be readily expelled by inverting the barrel and moving up the piston until a drop of the fluid presents itself at the orifice of the needle. In using a glass instrument which is graduated, more of the solution should be drawn into the barrel than it is contemplated to administer, and, fixing the eye upon those divisions of the scale representing the amount to be injected, the piston is made to traverse slowly the proper space. In filling my silver instrument I pursue the following method: I pour into a minim-glass the proper quantity of the solution. The needle being screwed into its place, I insert the point into the solution and draw the whole amount into the barrel of the syringe by slowly elevating the piston, inclining to one side the minim-glass, in order to take up the last drop. If air have entered, I invert the syringe and push up the piston slowly until it is

all expelled. An allowance of on[illegible] made for loss.

The mode of injecting, which is [illegible] follows:

Take up between the thumb an[illegible] left hand a loose fold of skin in som[illegible] ation. Push in the needle, with a [illegible] motion, at a right angle to the dir[illegible] The resistance ceasing, it will be kno[illegible] has perforated the skin, and the p[illegible] may also now be freely moved about ous areolar tissue. It is better to p[illegible] an inch or more under the skin, to hav[illegible] for the fluid. The injection must [illegible] drop by drop, so that the fluid may di[illegible] out rupturing any small vessels, or [illegible] connective tissue. When all has bee[illegible] draw the needle slowly, pressing at the the puncture to prevent escape of th[illegible] minutes' pressure will suffice to retain [illegible] arrest the little bleeding which sometim[illegible] A bit of isinglass plaster may also be puncture, but this is generally unnecess persons the fluid is always injected into this is the method of using strychnia in is not frequently adopted for other agent[illegible] podermically. To inject into a muscle, f[illegible] brachialis anticus, make it tense by flexin[illegible] and then by a quick motion thrust the n[illegible] into the muscle. It is claimed for this n[illegible] is less painful and less liable to be follow[illegible] than by the injection under the skin, but it

improper if any considerable amount of fluid is to be injected.

In practicing the hypodermic injection, it is important to avoid puncturing a vein. Serious depression of the powers of life, fainting, and sudden and profound narcotism have been produced by injecting a solution of morphia directly into a vein. Fatal collapse might be induced by injecting air into a large vein along with the solution.

Bony prominences should also be avoided, for in these situations the skin is not sufficiently loose to permit the ready entrance of the fluid, and inflammation and abscess will follow a too forcible injection.

The puncture should not be made, as a rule, into inflamed parts. I have known a bad phlegmon produced by injection into the tissues of an inflamed wrist.

It is not necessary to follow the original method of Wood, and inject into those points in which pain can be awakened by pressure. Some exceptions to this rule undoubtedly exist, as will hereafter be shown, but they are not numerous. The arm, the outer face of the thighs, the calves, the abdomen, and the back are suitable places for the injection. The arm, about the insertion of the deltoid, is generally selected. Eulenberg makes the assertion that the effect is slower when the injection is made in the back than in any other situation.* I have not been able to observe any difference in the rapidity of effect as influenced by the site of the puncture. If, as sometimes happens, the patient prefer injection into the painful part, it will be well to yield

* Die hypodermatische Injection, etc., op. cit., p. 62.

to his prejudices, provided no contraindication exist thereto.

If the patient be timid, and intolerant of pain, the sensibility of the skin may be lowered by ether or rhigolene spray. A piece of cotton cloth moistened with chloroform and held on the skin a few minutes is nearly as effective as the douche, and much more convenient. Sometimes redness and swelling take place at the site of the injection. This is best relieved by a cold wet compress.

The syringe, half-ounce glass-stoppered vials, containing the solutions most frequently used, and minim-glass, should be contained in a small leather pocket-case, at all times ready for use.

III.

GENERAL THERAPEUTICS.

A REMEDY administered by the stomach is affected in its physiological and therapeutical action by the condition of that organ. Disease, as for example gastric catarrh, limits, if it may not entirely prevent, the absorptive action of the mucous membrane. Also, the state of repletion of the veins, the presence of other ingesta, and the condition of annexed organs influence the rate and extent of absorption. The digestive fluid undoubtedly exerts a chemical action upon many remedial agents, thereby retarding, limiting, or preventing their physiological and therapeutical activity. Lastly, many agents, of the narcotic class especially, depress the nerves of the stomach, and, in this way, affect the rate and degree of absorption. On the other hand, when a medicine suitable for the purpose is thrown under the skin, its physiological and therapeutical effects are produced in the fullest degree and in the most characteristic form. It follows, then, that the therapeutical powers of a drug must not only differ in degree, but also in kind, according as it is given by the stomach or injected under the skin. Experience and observation demonstrate the truth of this statement. The subcutaneous use of certain drugs has developed very valuable therapeutical properties, which the stomachic administration had not even suggested. Bernard* affirms that this mode of administering remedies,

* Archives Générales, 1864.

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REMOTE OR SYSTEMIC EFFECTS.

As a cerebral sedative.....	In Insomnia. Melancholia. Mania. Puerperal mania. Delirium tremens, etc.
As a moderator of reflex action.....	In Epilepsy. Chorea. Eclampsia. Hysteria. Tetanus. Hydrophobia, etc.
As a motor excitant.....	In Paralysis, etc.
As an anodyne.....	In the various forms of neuralgia, etc.
In affections of thoracic viscera.....	Spasmodic cough. Hooping-cough. Asthma. Angina pectoris. Bronchitis. Pleuritis. Pericarditis, etc.
In affections of digestive system.....	Dyspepsia. Vomiting of pregnancy. Sea-sickness. Cholera morbus. Colic. Intussusception. Enteritis. Peritonitis. Hepatic colic. Schirrus, etc.

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salts.

Belladonna. (Atropa Belladonna.)	Atropia and its salts.
Hyoscyamus. (Hyoscyamus Niger.)	Hyoscyamia. Tincture.
Stramonium. (Datura Stramonium)	Daturia.
Coffee. (Caffea Arabica.)	Caffein.
Tobacco. (Nicotiana Tabacum.)	Nicotia.
Aconite. (Aconitum Napellus.)	Aconitia.
Conium. (Conium Maculatum.)	Conia.
Colchicum. (Colchicum Autumnale.)	Colchicia.
Nux Vomica. (Strychnos Nux Vomica.)	Strychnia and its salts.
Woorara.	
Digitalis. (Digitalis Purpurea.)	Digitalina.
Veratrum. (Veratrum Album.)	Veratria.
Ergot. (Secale Cornutum.)	Ergotina. Ergotin.
Calabar Bean. (Physostigma Venenosum.)	Extract; Physostigmia.
Hydrocyanic Acid.	
Cinchonia.	Quinia and its salts.
Ipecacuanha. (Cephaëlis Ipecac.)	Emetia.
Iodine.	Tincture; Iodide of Potassium.
Sodium.	Chloride.
Ammonium.	Chloride.
Iron.	Liq. Ferri Subsulphatis.
Copper.	Sulphate.

Chloral.	
Silver.	Nitrate.
Mercury.	Corrosive Sublimate. Biniodide.
Arsenic.	Liq. Sodæ Arseniatis.

Many of these agents have either proved unsuitable for subcutaneous injection or are inefficient. In the following pages I propose to consider those the utility of which has been established by experiment and clinical observation. They are the following:

Morphia and its salts.
Atropia and its salts.
Strychnia and its salts.
Conia.
Woorara.
Physostigma.
Caffea.
Nicotia.
Hydrocyanic acid.
Quinia and its salts.
Ergot.
Iodide of potassium; tincture of iodine.
Subsulphate and perchloride of iron.
Arseniate of soda; Fowler's solution.

In practice it will be found that this list may be much reduced. For the ordinary contingencies of medical practice, the following only are necessary:

Morphia (sulphate).
Atropia (sulphate).
Strychnia (sulphate).
Quinia (sulphate).
Ergotin.

The physician's hypodermic case should contain solutions of morphia, atropia, strychnia, and ergotin.

PART II.

Special Therapeutics.

I.

MORPHIA.

THE SOLUTION.—There is no general agreement as to the salt of morphia best adapted to hypodermic use. As the sulphate is the most soluble salt, this should be preferred. In Germany the hydrochlorate is much used. The formula of Eulenberg* is as follows:

℞.—Morphiæ hydrochlorat. gr. iv;
Acidi hydrochlor. gutt. iv;
Aquæ destill. ʒi. M.

In this formula the muriatic acid serves a double purpose: it increases the solubility of the morphia, and it prevents the development of the *penicillum*. But acid solutions, as I have already pointed out, increase the pain and smarting which attend the injection, and not unfrequently produce inflammation and abscess. The Committee of the Medico-Chirurgical Society, in their experiments, used the acetate of morphia dissolved by the aid of sufficient acetic acid, and afterward neutralized with liquor potassæ. The Committee wisely

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* Op. cit.

remark: "In using drugs which require an acid to render them soluble in water, it was found that very acid solutions were apt to irritate, and the solutions were therefore carefully neutralized." Would it not have been better to use a salt of morphia readily soluble in water without the aid of an acid, the more especially as the Committee had ascertained that pure water occasioned very little irritation?

Dr. Anstie, in a very valuable paper on "The Hypodermic Injection of Remedies,"* says that "morphia should be used in the form of acetate dissolved with a minimum of acetic acid in hot distilled water, five grains to the drachm." This solution, it appears to the writer, is objectionable in several respects. It is too concentrated, one minim containing one-twelfth of a grain, a quantity difficult to inject with accuracy by an ordinary syringe. Dr. Anstie himself states another objection: "As the salt varies in solubility, it will often happen that, on cooling, the solution will solidify. This is not of much consequence, as it can be heated in hot water at the moment of use."

I prefer a simple solution of the sulphate, according to the following formula:

℞.—Morphiæ sulphat. gr. xvi;
Aquæ destill. ʒi. M.
Dissolve and filter.

The morphia should be rubbed up in a mortar and the distilled water added gradually. A perfect solution will be obtained, which does not require an acid. Fifteen minims represent half a grain; five minims a sixth of a grain.

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* The Practitioner, July, 1868.

Dr. Wilson,* after an elaborate review of the subject, concludes, "that the solvent for morphia should be distilled water without any admixture of acid."

A solution of morphia for hypodermic use should be prepared about the time of the expected administration. Even if free from foreign matter, and carefully filtered, it undergoes a change by keeping, which renders it irritating to the tissues. For this reason it is better for the physician to carry with him powders of morphia containing different quantities, and dissolve them in sufficient water when required. Clear spring, well, or cistern water, or melted ice, will answer instead of distilled water, and unless the latter be fresh and pure, it is not to be preferred. Since I have adopted the method of extempore preparation of the morphia solution, I have not had occur the hard nodules and points of suppuration which were not infrequent when the regular solutions were used.

Dr. Lawson† recommends a solution of the muriate, gr. x ad aquæ destil. ℥ij. This solution is solid at ordinary temperature, and requires heating to give it fluidity. Six minims contain a half grain of morphia.

Dose.—The dose of morphia for hypodermic use varies from $\frac{1}{12}$ to $\frac{1}{2}$ of a grain. *In commencing it should not exceed one-third of that ordinarily administered internally.* It is prudent in all cases to test the physiological capabilities of the patient by a moderate dose before resorting to the maximum amount. Patients vary in their susceptibility. Women are, as

* St. George's Hospital Reports, vol. iv. 1869.

† Medical Times and Gazette, Nov. 12, 1870, p. 555.

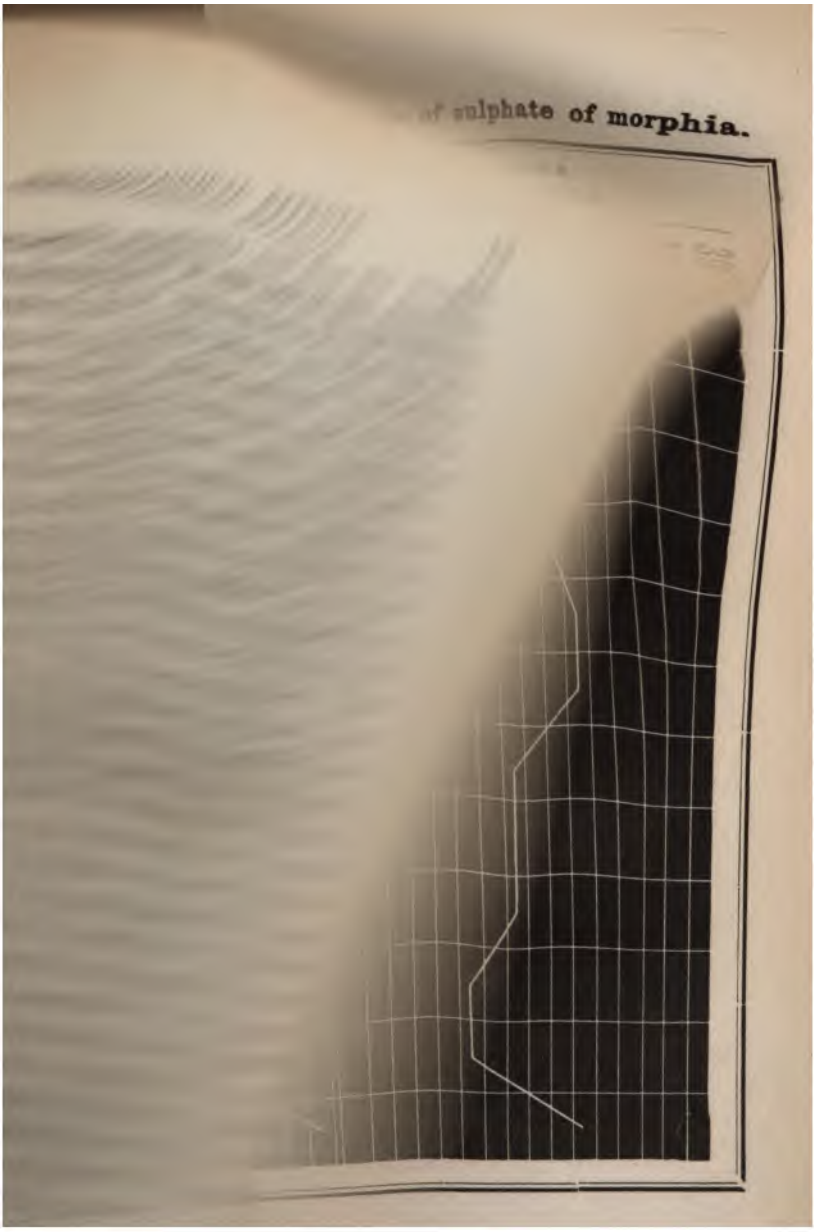
a rule, more easily affected than men. One-twelfth of a grain is a sufficient dose for many of the conditions requiring an injection. Persons habituated to the use of the drug, or those suffering pain, will bear a larger quantity. The maximum doses may be administered with safety if combined with atropia (see *post*). As Brown-Séquard has indicated, large doses of morphia, when combined with atropia, exert a more decided curative effect in obstinate neuralgias. It may be necessary in such cases to give $\frac{1}{2}$, and even 1 grain of morphia, with $\frac{1}{48}$ of a grain of atropia.

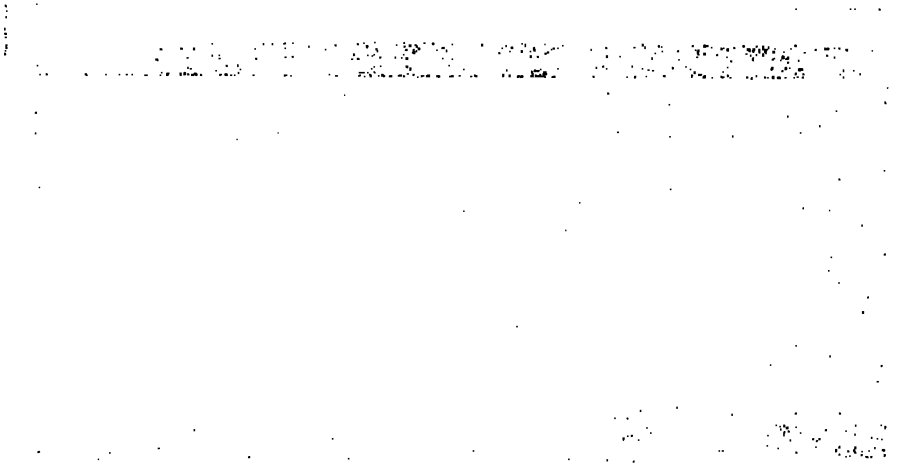
In order to maintain a constant physiological effect, but slight increase of the dose is necessary. This is one of the greatest advantages of the hypodermic method, especially in cases requiring the protracted use of morphia.

Hypodermic injections of morphia are rarely advisable in the case of children, yet as their utility is unquestionable in certain convulsive disorders of early life it may be necessary to employ them. From $\frac{1}{20}$ to $\frac{1}{10}$ of a grain, according to age, is a sufficient dose. I have not ventured to use the injection in children under three years of age.

As the quantity proper to be administered is differently stated by different authorities, I desire to impress upon my readers the necessity for caution. The large doses sometimes recommended—$\frac{1}{2}$, $\frac{3}{4}$, and even 1 grain—are unsafe for the first trial, unless the condition requiring the injection be exceptional.

Physiological Effects.—When the solution is injected, a pain, compounded of smarting and burning, is experienced in the part, and this is followed by


of sulphate of morphia.



time, I discovered a marked increase of vascularity of the retina and blurring of the papilla.*

Soon after the injection, more or less decided itching of the nose,—and in many persons during the time the morphia narcosis is at its maximum, an irritation of the whole cutaneous surface,—are experienced. This effect is usually followed by general diaphoresis,—the sweating being in many instances very profuse.

With the development of the morphia narcosis there occur dryness of the mouth and fauces and an arrest of secretion in general, except that of the sudoriparous glands. If the injection be administered after a full meal, digestion is suspended, the food remaining unchanged in the stomach for several hours. As a rule, constipation results; but to this there are numerous exceptions, for in some instances I have known the peristaltic movements to be actually increased. In common with the other organs, and possibly, also, in consequence of the diaphoresis, the functional activity of the kidneys is lowered, and the amount of urine secreted is much below the normal. More or less difficulty is experienced in the emission of urine; when the desire is felt, a long interval elapses before the flow takes place, and, as the contractile power of the bladder and of the ejaculatory muscles is diminished, the emission of urine is slow.

With the decline in the morphia narcosis, some patients experience headache, confusion of mind, anorexia, and nausea, but these results are not so constant

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* Transactions of the Ohio State Medical Society, 1871, p. 228.

as after the internal use of this agent. If the injection be administered at night, the nausea and vomiting are experienced on rising in the morning. Perfect quiet, a cup of hot coffee taken before rising, an ice-bag to the cervical spine, a full dose of the bromide of potassium, may be administered for the relief of these symptoms when they are severe.

The extent and persistence of the foregoing physiological effects will depend upon the quantity of morphia injected. Very large doses excite not only immediate disturbance in the functions of the brain, but secondary disturbances in the process of elimination of the narcotic from the blood. The occurrence of these unpleasant and depressing effects of the morphia narcosis is an additional reason for cautious tentative experiments in any case in which the physiological tolerance of this agent is unknown.

Phenomena somewhat different in character, as well as in degree, from those which I have described under this head, follow the subcutaneous injection of large doses. The following symptoms were observed by me after the injection of one grain of sulphate of morphia:

In ten minutes the patient had fallen asleep so soundly, sitting upright in bed, that he could not be aroused. At the end of an hour I found him in a state of profound narcotism, his pulse 50 and feeble; respiration 10 and labored, with stertor; skin cold and sweating; face pale and ghastly. The conjunctivæ were deeply injected; pupils minutely contracted, and insensible to the strongest gas-light. No reflex movements could be excited by touching the eyes, or by irri-

tation of the fauces. These formidable symptoms were relieved by the subcutaneous injection of atropia, but the patient slept twenty hours. Great difficulty of micturition was experienced for twenty-four hours longer. Injection of the conjunctivæ, huskiness of voice, and some difficulty in swallowing persisted for forty-eight hours.

The effects of an ordinary dose, $\frac{1}{4}$ of a grain, continue from twelve to eighteen hours, according to the susceptibility of the patient. It follows, then, to maintain the morphia influence in any given case, two doses per diem will, generally, be sufficient.

Are there any ill effects produced by the long-continued use of morphia when injected under the skin? This is a practical question of considerable importance. I have not observed effects different in character from those produced by the long-continued internal administration, except in one case. In this instance extreme volubility, complete insomnia and restlessness were induced by the subcutaneous injection of half a grain of morphia every four hours. This patient, the unhappy subject of uterine cancer, was advised by her physician to use for the relief of her pain the hypodermic injection of morphia. As the attendants of this woman used the syringe, they were prevailed on, by the evident extreme suffering which she endured, to increase the dose to the point named. At the end of three months she began to be restless, and complained that the effect of the morphia was no longer the same. She could not sleep; her restlessness became extreme; her extremities and the muscles of her head and face were agitated by choreic spasms; her eyes were bril-

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his usual dose he was cheerful, active, and attentive to his affairs.

I have under observation another patient sixty-two years of age, who, for a painful affection of the bladder, has taken twice each day a hypodermic injection of ½ grain of morphia for two years. He has had on two occasions morphia horrors, which required large doses of the bromide of potassium, but his bodily and mental activity are at present at their maximum of efficiency, and his malady has been most decidedly ameliorated.

In consequence of these facts and others which I have observed, I cannot admit the correctness of Clifford Allbut's deductions in regard to the prolonged use of morphia hypodermically administered.* That morphia used in this way will induce a habit, in all respects similar to, only more enslaving than, the use of opium internally, is certainly true, and we constantly meet with patients who habitually use the hypodermic syringe as we formerly encountered "opium-eaters."

But the question is—do we find that the prolonged use of morphia, hypodermically administered, gives rise to symptoms different from and more serious than those brought about by opium-eating? Dr. Allbut alludes to a class of cases, neuralgia chiefly, in which the morbid state of the nerves seems to be kept up by repeated morphia injections; but is not this the case with opium-eaters as well?

THERAPY.—The subcutaneous injection of morphia may be used to relieve pain, to relax spasm, to subdue

* On the Abuse of Hypodermic Injections of Morphia. The Practitioner, vol. v. p. 327.

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of Pain, etc., pp. 18, 19.

neously, in simple mania and in hysterical mania. Krafft-Ebing considers the same mode of treatment the most efficacious for the relief of the insomnia so common in the insane.* My own experience, which has been limited, however, is very favorable to the subcutaneous injection of morphia. In a case of acute melancholia, characterized by insomnia and intense restlessness, I found this method of treatment exceedingly useful. A grain of morphia reduced the pulse from 140 to 96, quieted the agitation, and procured sound and refreshing sleep.

Robertson in the paper referred to gives three typical cases of different forms of insanity—recent mania, chronic mania, and melancholia—in which the hypodermic injection was successful. The indications for the employment of this method are the following:

Prolonged wakefulness.

Maniacal excitement.

Obstinate and persistent refusal of food, or drink, or medicine.

Destructive and suicidal tendencies.

Maudsley adds a caution here, which I transcribe for the benefit of my readers: "It will be well to have in mind that neither opium by the mouth, nor morphia hypodermically injected, will always quench the fury of acute mania, and that successive injections of morphia, followed by brief snatches of fitful sleep, have been followed, also, by fatal collapse." The evidences of the beneficial effect of the injection are the following:

Prolonged and healthy sleep.

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* Bulletin Général de Thérapeutique, Jan. 30, 1870, p. 474.

Less excitement on awakening.

Illusions or delusions less strong.

Willingness to take food.

Absence of any tendency to collapse, although pulse, temperature, and respiration are reduced.

To produce the best results, larger doses than those I have indicated as proper in general are necessary in the treatment of mania. Hunter administered ½ and 1 grain; Robertson speaks of ½ grain of the acetate of morphia injected every four hours, and in one case of 1 grain injected night and morning. In cases which have occurred under my observation, extraordinary tolerance of the morphia was exhibited; and in that case to which I have made special reference, 1 grain was found necessary to procure sufficiently prolonged sleep.

It is in the beginning of mania that the hypodermic injection of morphia is most conspicuous for good. The timely use of the syringe may avert this disorder in that critical period when the occurrence of unusual excitability and sleeplessness indicates that an outbreak is imminent. This observation is especially true of puerperal mania. The introduction of chloral hydrate has modified somewhat the treatment of maniacal affections by the subcutaneous use of morphia; but, as Wolff has shown, each has its own sphere of applications.

Delirium Tremens.—We owe to Mr. Hunter the first suggestion of the hypodermic treatment of *delirium tremens*. It was afterward employed by Ogle, Semeleder, Lorent,* Eulenberg,† Ruppaner,‡ and others.

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* Op. cit. † Op. cit.

‡ Hypodermic Injections, 2d ed., p. 132.

Dr. Anstie, in an able paper on "Alcoholism,"* thus formulates his views as to the utility of this method:

"Opium should never be administered by the stomach, but always in the form of morphia hypodermically injected, in the dose of $\frac{1}{10}$ to $\frac{1}{4}$, or $\frac{1}{2}$ grain."

The treatment of delirium tremens has undergone a radical change within the past few years. This is well expressed in the following observations by Dr. Anstie:

"In former times—indeed, a very few years since—the notion universally prevailed that the delirious symptoms were owing to the exhaustion which was chiefly kept up by want of sleep; and, consequently, that the production of continuous sleep for several hours was the sole and all-important means of cure. It was therefore the custom to ply the patients with larger and larger successive doses of opium, with the view of drowning the delirium in narcotic stupor. Great mischief arose from this wide-spread belief and practice. In the first place, it has often happened that the patient, without ever sleeping at all, has passed first into a condition of coma-vigil, next of stertorous breathing, and at last sunk, fairly poisoned with opium."†

I have quoted these strong but just expressions to warn my readers against the abuse of the hypodermic injection of morphia in the treatment of delirium tremens.

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* Reynolds's System of Medicine, vol. ii. p. 90.

† Ibid., pp. 88, 89.

The following are the indications for the use of this method in this disease:

The condition of "horrors," or wakefulness, preceding delirium.

Excessive and uncontrollable vomiting of food, drink, and medicine.

Mild cases, in which there is little tendency to depression of the vital forces, and in which the assimilation of food proceeds satisfactorily.

It is contraindicated in severe and protracted cases, with great depression of the vital forces and non-assimilation of food;

In cases in which serious organic lesions of liver or kidneys have occurred;

In cases in which the delirium tremens is consecutive to traumatic or other serious lesion of brain.

In **cerebro-spinal meningitis** opium is the best remedy, especially in the onset of that disorder, and, according to Radcliffe,* the hypodermic injection of morphia is the best method of administration. Erlenmeyer,† who appears not to have had any personal experience with the hypodermic use of morphia in this disease, refers to the experience of Bois. According to Eulenberg,‡ Niemeyer used this method as a palliative in an epidemic at Rastadt and Carlsruhe. It relieved the pain and cramps, and quieted the extreme restlessness (*grosse Unruhe*), which are marked phenomena in these cases. Dr. B. Arnold, of Donzdorf, reports favorably of its use in these cases.§ According to

* Reynolds's System of Medicine, vol. ii. p. 702.

† Die subcutanen Injectionen, op. cit., p. 31.

‡ Die hypodermatische Injection, op. cit., p. 156.

§ Schmidt's Jahrbücher, vol. cxxvii. s. 163.

Stillé,* the opium treatment was very serviceable in the disease as he observed it in Philadelphia. I have no personal experience to offer. I have no doubt, however, that the hypodermic injection of morphia is a remedy of great utility in this disease; but it should be used with the same caution which I have enjoined upon my readers as necessary in the treatment of acute mania.

In the psychical disorders *insomnia* is a prominent symptom, for the relief of which the morphia injection is especially indicated. When insomnia is the substantive disorder, a combination of morphia and atropia is better than morphia alone,—a fact which I shall develop in a future chapter.

In the treatment of **coup-de-soleil, sun-stroke,** very unexpected and gratifying results have been obtained by Dr. Hutchinson, at the Pennsylvania Hospital.† He injected one-fourth of a grain of the sulphate of morphia, which produced almost instant relief, and was followed by rapid recovery.

Hysteria.—In England Hunter,‡ in Germany Lander and Fronmüller,§ were the first to employ the hypodermic method with morphia in the treatment of hysterical convulsions. Lorent‖ recommends it in *hysterical melancholy.* In my own experience, no remedy has acted so promptly and satisfactorily in terminating a hysterical paroxysm as this. One-twelfth to one-eighth of a grain of sulphate of morphia is sufficient for this purpose.

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* Epidemic Meningitis. Philadelphia, 1868.

† Pennsylvania Hospital Reports, vol. ii. p. 291.

‡ On the Speedy Relief of Pain, etc., l. c.

§ Eulenberg, l. c. ‖ Op. cit, p. 17.

jection at once suspends the severe pain and burning (intercostal neuralgia) which accompany this disease, and cuts short the duration of the eruption.

Next to the severer forms of tic, the most troublesome neuralgic disorder with which we have to deal is *sciatica.* I may affirm with regard to this what Dr. Anstie has remarked about epileptiform tic, that the hypodermic method has inaugurated quite a new era in its remedial management.

In severe and protracted cases, in which changes in the nerve and in the nutrition of the limb have taken place, permanent relief cannot always be guaranteed to the patient; but the injections steadily continued in the maximum doses will, in a great majority of cases, effect a cure finally. When morphia fails, atropia may be tried, and *vice versa;* or both, as is preferable in my experience, may be employed together.

Dr. Lawson,* who has had not only an unfortunate personal experience with this troublesome malady, but has had a number of cases under treatment, concludes that the hypodermic injection of morphia "*is almost the only remedy for sciatica.*" He advises the injection to be made into the thigh four inches below the hip-joint, and over the course of the nerve.

The other varieties of neuralgia call for no special comment. The principles of treatment are the same in all.

Notwithstanding the utility of hypodermic injections of morphia in the treatment of neuralgia, no judicious physician will rely upon them exclusively in the man-

* Medical Times and Gazette, Nov. 12, 1870, p. 650.

agement of severe cases. Anæmia must be corrected by iron, cod-liver oil, the hypophosphites, etc. A suitable dietary and hygiene must be enforced. Meanwhile, if the pain is not permanently relieved by the injections, the existence of the patient is rendered endurable while a proper remedial management is being pursued.

Is it necessary to confine the limits of the injections to the site of pain, or to the painful spots? I have already indicated my belief that the position of Mr. Charles Hunter is, in the main, correct,—that "localization" of the injection is unnecessary. But I admit the fact that exceptions exist.

Dr. Wood, the discoverer of the hypodermic method, Prof. Béhier, Erlenmeyer, Lorent, Eulenberg, and Messrs. Mitchell, Morehouse, and Keen,* think that better results follow injection into the painful spot. Dr. Anstie, although believing that remote injection is equally as effective in general, admits that exceptions are occasionally met with. Eulenberg bases his opinion on the fact that tactile and pain sensibility are diminished at the site of the injection.

For deep-seated neuralgias localization of the injection is impracticable. In superficial neuralgias, the nerve being readily accessible, it is comparatively easy to inject the fluid into the tissues surrounding the nerve. This practice is better than remote injection in cases of sciatica and of zoster, and in all cases of long standing in which the sheath or trunk of the nerve has become altered. When neuralgic pain is

* American Journal of the Medical Sciences, July, 1865.

purely local, produced by alterations of nerve trunks, as, for example, many cases of sciatica, the injection of various irritants into the vicinity of the diseased nerve will often be followed by notable diminution of the pain, and sometimes by cure. This important fact has been demonstrated by Luton,* Bertin,† and Ruppaner.‡ It is probably in this way that local injections sometimes succeed when remote injections fail.

Diseases of the Respiratory and Circulatory Systems.

There are certain neuroses of the respiratory tract which may be quickly relieved, if not cured, by the hypodermic method.

Laryngismus Stridulus.—Spasm of the muscles of the larynx, due to reflex irritation, is promptly relieved by the subcutaneous injection of morphia. In children, of course, a very minute quantity of morphia is necessary or proper. In adults a similar condition exists, due to pressure on the recurrent laryngeal nerves. In this case the relief is temporary, but for the time it is most striking. In *hysterical aphonia*, one injection will generally cure.

Cough.—That form of cough which is maintained by habit, and which so frequently succeeds to hooping-cough in adults, is quickly curable by this means. No method of treatment is so effective in hooping-cough as this; but with morphia atropia should be conjoined, in order to secure the best results. In the cough of phthisis, as a palliative and to procure rest at night,

* Archives Gén. † Ibid.
‡ Hypodermic Injections, op. cit.

the hypodermic injection is preferable to the internal use of morphia.

Asthma.—For the relief of an asthmatic paroxysm, there is no means now known comparable to the hypodermic injection of morphia or atropia. Prof. Sée,* influenced by theoretical considerations, condemns the internal use of opium: "Opium," he says, "acts inversely to belladonna; it diminishes the frequency of breathing to the damage of the patient." He therefore recommends belladonna, a medicine styled by him "a vascular agent." Clinical experience is opposed to these theoretical views. I have ascertained that the hypodermic injection of morphia produces the following results in asthma:

It promptly relieves the paroxysm, enabling the patient to lie down and sleep.

It lengthens the interval between the attacks.

It renders succeeding paroxysms milder.

Ordinarily, I combine atropia with the morphia, in order to give large doses with safety; for in this disease, as in many other neuroses, the maximum doses are often required to accomplish relief. Prof. Hirtz has also found that the subcutaneous injection of morphia produces "marvelous results" in asthma. Although after an extensive use of this treatment I cannot affirm that any cases have been cured, I can assert that, besides the immediate relief, permanent amelioration has been obtained in all submitted for any length of time to the treatment.

In any ordinary case of spasmodic asthma, five min-

* Practitioner, July, 1869, p. 1, et seq.

lunar disease, as suggested by Lorent. Violent palpitations occurring under these conditions, produced by mental emotion, reflex irritation, or other perturbating influences, may be palliated by this means; but my own observation is unfavorable to the use of hypodermic injections in cases of narrowing and obstruction of the aortic orifice. I have, however, used it with advantage—morphia and atropia combined—in cases of dyspnœa dependent upon dilated right cavities, pulmonary œdema, and mitral disease.

Diseases of the Digestive Apparatus.

Whenever opium or the alkaloid morphia is indicated in any case of disease, and anorexia exists, the remedy should be administered by subcutaneous injection; such is the formulated expression of Dr. Anstie. Although morphia, when exhibited in suitable doses hypodermically, is much less apt to produce nausea and vomiting than when taken into the stomach, these unpleasant after-effects are not always absent after the former mode of administration. It is certainly true, however, that the hypodermic method does not nearly to the same extent interfere with digestion and assimilation.

Dyspepsia.—Dr. Clifford Allbutt,* of Leeds, England, is an enthusiastic advocate of the hypodermic injection of morphia in nervous dyspepsia with intolerance of food. I have myself seen cases in which the action of morphia was as happy as it proved in the hands of Dr. Allbutt. The relief which it affords is great in *gastralgia.* By allaying pain, arresting vom-

* The Practitioner, vol. ii., 1869, p. 341.

iting, and saving waste to the system at large, the hypodermic injection of morphia contributes powerfully to the cure of *gastric ulcer*. It is a remedy of the greatest value in the treatment of *acute gastritis*, quieting the viscus until the morbid process subsides, and obviating the necessity for the stomach administration of anodyne drugs.

One-fourth of a grain is a sufficient quantity to be injected daily in cases of dyspepsia, gastralgia, and ulcer. In acute gastritis, this quantity may be necessary every four or six hours. The site of the injection is of little consequence, but patients generally prefer the epigastric region.

Scirrhus.—In cases of *scirrhus* of any portion of the digestive tract, especially of the stomach, no palliative is comparable to the hypodermic injection of morphia. The existence of a patient afflicted with scirrhus of stomach is not only prolonged, but is rendered comparatively peaceful and calm, by this treatment, for it diminishes or arrests the vomiting, enables the food to be assimilated, gives freedom from pain, promotes sleep, and thus saves the strength.

Cholera.—The most instantaneous and striking relief is afforded by the hypodermic injection of morphia in *sporadic cholera*. It is indicated in this disorder after the irritant cause, whatever it may be, is evacuated from the intestinal canal. From one-sixth to one-half a grain, according to the severity and violence of the attack, may be injected into the epigastrium. The subcutaneous injection is strongly indicated in *epidemic* or *Asiatic cholera*. In this disease, the gastro-intestinal mucous membrane is not in a condition to

appropriate remedies; hence the subcutaneous method is eminently rational.

Dr. Patterson,* of the British Seamen's Hospital, Constantinople, has employed the hypodermic injection of morphia in a recent cholera epidemic. Of 10 cases "treated in the usual manner," 9 died and 1 recovered. Of 42 cases treated by morphia subcutaneously, 22 recovered and 20 died. Of these 42 cases, 8 were *in articulo mortis* when admitted, 1 had a severe disease of the liver, 1 was far advanced in consumption, 1 was sixty years of age, 1 was near her confinement, and 3 were intemperate. Dr. Asche† treated two cases of cholera by this method successfully.

The Vomiting of Pregnancy has been relieved by the hypodermic injection when all other means had failed. For the milder cases this treatment is unnecessary and improper; but in those severe cases in which life is reduced to the lowest ebb by the continual vomiting, and in which forced abortion has hitherto seemed the appropriate remedy, it is eminently successful. In all severe cases in which the ordinary remedies fail to give relief, recourse should be had to the hypodermic method. A daily morning injection ($\frac{1}{12}$ to $\frac{1}{4}$ grain), administered during the period of greatest difficulty, will enable gestation to proceed without danger to the mother, and without the necessity of adopting that serious alternative—abortion.

Colic.—In my practice I employ no other means

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* Medical Times and Gazette, Jan. 27, 1872.

† Schmidt's Jahrbücher der Gesammten Medicin, Band 125, s. 331–7.

of relieving the pain and spasm of colic. In most of these cases, of course, further treatment is necessary: constipation must be relieved; obstructions be overcome; the saturnine cachexia be removed; but the injection, by relieving spasm of the muscular layer of the bowel, permits these effects to be produced much more easily and speedily than would otherwise be possible. Cases of hepatic colic, within the range of my observation, have been quickly relieved by the hypodermic injection of morphia, where opium internally failed to produce the least mitigation of the pain, and where the inhalation of chloroform procured only the most temporary respite. When pain is very excessive, the reader should remember small doses may not suffice, but one-fourth and even one-half a grain may be necessary, repeated according to circumstances.

The same observations are applicable to *nephritic* and *uterine* colic.

Peritonitis.—Opium being the remedy *par excellence* for inflammation of serous membranes, the hypodermic injection of morphia should be employed in all cases in which promptness and completeness of effect may be desired. This is especially the case in peritonitis, whether primary or secondary. Moreover, as in many cases of this disease the alimentation is of prime importance, and as nausea and vomiting are frequently present, the stomach administration should be deprecated, and the hypodermic be preferred.

Neuralgia.—In the various forms of neuralgic pain which affect the abdominal organs, whether *gastralgia*, *enteralgia*, *hepatalgia*, *nephralgia*, etc., no remedy

procures so prompt and, in many cases, complete relief as the hypodermic injection of morphia.

Constipation.—In many cases of colic due simply to constipation, the injection not only relieves the pain but overcomes the constipation. It is true that in many cases the first injection temporarily suspends the peristaltic movements, but when habitually used this effect disappears, and the normal movements are not diminished, but promoted. Cases in which constipation existed have thus been corrected during a course of hypodermic injections. A physiological fact which I have already noted throws light upon this: in a few seconds after the injection borborygmi and distinct intestinal movements are observed. If, then, constipation exist in cases in which it may be desirable to use the hypodermic injection of morphia, this circumstance need not be considered a contraindication.

Diseases of the Genito-urinary Organs.

I have already indicated the utility of the hypodermic injection of morphia in nephralgia and nephritic colic. Lorent* refers to its use in parenchymatous nephritis, to relieve the headache of uræmic intoxication. My own experience is unfavorable to the use of hypodermic injections of morphia when the kidneys are seriously damaged.

Affections of the Bladder and Urethra.—In cases of chronic cystitis, I have given great relief by the hypodermic injection. It suspends those violent ex-

* Die hypodermatischen Injectionen, op. cit.

pulsive efforts which occasion the principal suffering. In *acute cystitis* the injection, by procuring quiet to the organ, and by diminishing the irritability of the mucous membrane, will directly contribute to the cure. The sufferings of the patient afflicted with *calculus* may be thus prevented until operative measures can relieve him permanently. *Spasm of the bladder* is quickly relieved by the same means; as also that painful but obscure affection, "the bar," which sometimes succeeds too violent and prolonged sexual intercourse. The hypodermic injection may also be used to relieve *spasmodic stricture*, but for this purpose, it is by no means equal, in my experience, to chloroform. It is convenient to blunt the sensibility preliminary to the operation of catheterism, and is a capital means for relieving *chordee*, and prolonged and teasing erections. But to prevent unpleasant erections and nocturnal losses, the use of morphia and atropia together is preferable to morphia alone. For information on this subject I refer the reader to the chapter on "Morphia and Atropia."

The hypodermic injection of morphia is capable of a variety of important uses in obstetric practice. It promptly arrests those *false and irregular pains* at the beginning of labor, which annoy the woman without advancing the case. In primipara, it has been used to diminish the sufferings of labor. It is much better than morphia by the stomach, to procure rest and sleep during a prolonged first stage. No remedy is equal to the hypodermic injection of morphia for the relief of *after-pains*. In all of these circumstances no fear need be entertained that the judicious use of

the injection will interfere with regular uterine contractions. The quantity to be administered will vary from one-sixth to one-fourth of a grain; the latter amount need rarely be exceeded.

The pain of *dysmenorrhœa* can be promptly relieved by subcutaneous injection of morphia; but for all pelvic pain, as Dr. Anstie has remarked, atropia is the best remedy. As a palliative in *scirrhus* of *the uterus* and of the *mammæ*, the hypodermic injection of morphia is much superior, in respect of economy and effectiveness, to the stomach administration of the same drug. Lastly, on this topic, in all cases of severe pain involving any of these organs the hypodermic injection of morphia is indicated.

Diseases of Constitutional or Specific Origin.—Dr. William Henry Fuller writes enthusiastically of the great value of the hypodermic injection of morphia for relieving the pain of acute rheumatism. I shall have some remarks to make in a succeeding chapter upon the use of morphia and atropia in that disease, and will not now anticipate. I have used with great advantage the hypodermic injection of morphia to relieve the *nocturnal pains* of *tertiary syphilis*. Besides the complete and permanent relief to the pain which I have procured by persistence in the injections, I have observed, also, remarkable improvement in the lesions of bones and muscles. Not only in syphilitic but other forms of disease in which pain precedes, and in which an altered condition of the nerves produces structural changes of tissue, I have observed that relief to the pain is followed by cessation of the morbid process in the part. This fact is well shown in

zoster, an affection of the skin dependent upon some functional disturbance of its sensory nerves, which disappears very promptly after relief of the hyperæsthesia. Of course, in syphilitic neuralgia, the hypodermic injection should not be used to the exclusion of the iodide of potassium. In the cases in which I have employed it the pain persisted notwithstanding repeated use of large doses of the iodide,—a condition of things not unfrequently encountered, for long use of this remedy, and to the point of saturation—to borrow a term from the chemists,—induces a tolerance fatal to therapeutical efficiency.

In Certain Surgical Diseases and Operations.—To prevent shock, and to relieve pain after operations and injuries, the hypodermic injection of morphia is not as much used as it should be. No means affords such relief as this in the first few hours after *fracture* or *dislocation*. The reduction of dislocations may be facilitated, and the pain prevented by the injection, in cases where it is undesirable or impracticable to use chloroform. It has recently been shown* that the *reduction of strangulated hernia* is much facilitated by the same means. In all operations requiring the knife, to prevent the after-pain, to sustain the vital powers, and to maintain the necessary quietude of wounded parts, the hypodermic injection of morphia should be used.

To aid Chloroform Narcosis.—Bernard† made the important discovery that the use of morphia sub-

* The Practitioner, August, 1869.

† Bulletin Général de Therapeutique, vol. lxxvii. p. 241 et seq.

cutaneously, previously to the inhalation of chloroform, aided materially in the production of anæsthesia, and with a much smaller quantity of chloroform, and prolonged the stage of narcosis so that continued inhalation was not required. Nussbaum, the distinguished surgeon of Munich, soon after made the same observation independently. He ascertained further that the subcutaneous injection of morphia prevented the after-depression of chloroform narcosis. Dr. Wm. Warren Greene, of Pittsfield, Mass., long afterward announced the same fact, without, however, being aware apparently of the discovery of Bernard and the practical application of the discovery to surgical practice by Nussbaum.

Beside the great advantage of procuring anæsthesia by a smaller amount of chloroform, and of lengthening the duration of the narcosis, it is probable that the hypodermic injection of morphia obviates the tendency to death. Under these circumstances it may well occasion surprise, that chloroform inhalation should be undertaken by the surgeon without the preliminary use of morphia subcutaneously.

As a Physiological Antidote.—The subcutaneous injection of morphia may be used against the toxic effects of its physiological antagonists. The chief agents having this relation to morphia are the alkaloids of the family *Solanaceæ*. In a subsequent chapter, devoted to morphia and atropia, I will state the conclusions at which I have arrived in regard of the antagonism of these two agents.

The subcutaneous injection of morphia has been used against *strychnia poisoning*, but it is not so effect-

ive as physostigma. It has been used also against *poisoning by digitaline*, but for this purpose it is inferior to atropia.

The Morphia Habit.—Before concluding this section it may be desirable to make some observations on the habit which is engendered by long-continued use of the subcutaneous injection of morphia, and the best method of avoiding the unpleasant sensations which occur when the injection is discontinued. As when morphia is administered for a lengthened period by the stomach, so after long-continued hypodermic injection, the brain and nervous system become accustomed to the influence, and demand its repetition. If the injection have been administered at a regular hour for some time, the patient soon begins to experience characteristic nervous sensations as the time of the injection approaches; he becomes restless and "fidgety"; he is wakeful, and all his senses become acute; he experiences a feeling of vertigo and fullness of the head, with nausea, and sometimes vomiting. If the injections be suddenly suspended, much more serious disturbances become manifest: the patient lies awake at night, and is agitated with that terrible nervous sensation best expressed by the term "fidgets"; if sleep occur, it is short and fitful, and disturbed by horrible dreams and visions; during the day an inexpressible anxiety and restlessness is felt, rendering the patient unable to fix his mind on any subject, and making him the prey of the gloomiest apprehensions. He suffers from indigestion, nausea, and vomiting, and sometimes from diarrhœa; his appetite is poor, and the food, when eaten, lies heavily upon his stomach until ejected. Accom-

panying these symptoms there are observed great muscular weakness and prostration, short and difficult breathing, rapid and tumultuous action of the heart. In extreme cases all of these symptoms exist in an exaggerated degree. The mental disturbance assumes a more prominent place; wakefulness, a suicidal tendency, hallucinations, and decided mental alienation may at last appear.

The degree in which these conditions will be produced by abrupt cessation of the injection will depend upon sex, constitutional peculiarities, length of time the habit has continued, and the *per diem* quantity which has been administered. They may be averted by judicious treatment. After quite a large experience in this method of treatment, I am able to say that I have not yet experienced any special difficulty in ceasing the injections after long use by following these rules:

Never stop the injections suddenly.

Diminish the dose very gradually, without the knowledge of the patient.

Never use morphia alone for a lengthened period, but with atropia.

As the morphia is diminished, increase the proportional quantity of atropia until the effects of the latter preponderate.

When the effects of the atropia are fully experienced the patient will generally begin to complain that the injection has lost its peculiar influence, has become unpleasant, and will desire that it be discontinued.

II.

ATROPIA.

THE SOLUTION.—The sulphate is the salt chiefly employed for hypodermic use. This supplies all the conditions: it is readily soluble in water; the solution is free from irritating qualities. The formula which I employ is the following:

℞.—Atropiæ sulphat. gr ij;
Aquæ destil. ℥i. M.

Five minims of this solution represent one-forty-eighth of a grain. A much stronger solution may be used, as the following:

℞.—Atropiæ sulphat. gr. i;
Aquæ destil. ʒi. M.

A minim of this represents one-sixtieth of a grain. Or the following may be preferred:

℞.—Atropiæ sulphat. gr. i;
Aquæ destil. ʒij. M.

A minim of this contains one-one-hundred-and-twentieth of a grain. I prefer the first solution for these reasons:

It is sometimes desirable to inject very minute

quantities in susceptible subjects, and this cannot be done when the solution is very concentrated.

The dose may be much more varied in a weak solution.

A *penicillum* develops very rapidly in an atropia solution, and at the expense of the atropia; the more concentrated the solution the greater the loss.

I have elsewhere stated the general objections to strong solutions, which apply to atropia.

On account of the rapid growth of the *penicillum*, the solution of atropia should not be kept too long, but should be prepared in small quantity frequently during warm weather. Filtration will, of course, free the solution from visible impurities, but considerable loss of strength will be noticeable each time.

Dose.—Extraordinary discrepancies are to be found in the statements of various authorities as to the quantity of atropia which may be used subcutaneously. Dr. Anstie* notes with surprise the large quantity advised by Trousseau,—$\frac{1}{12}$ to $\frac{1}{6}$ of a grain,—a quantity sufficient to produce most serious toxic symptoms. Dr. Ruppaner† gives the dose at $\frac{1}{60}$ to $\frac{1}{30}$ of a grain, Lorent‡ at $\frac{1}{25}$ of a grain, and Courty employed so much as $\frac{1}{6}$ of a grain at a single operation. Five minims of the solution which I recommend to the reader, or $\frac{1}{48}$ of a grain, is the largest amount desirable to use in most cases. Very great differences in the susceptibility to the atropia influence are found to

* The Practitioner, op. cit.

† Hypodermic Injections, op. cit.

‡ Die hypoder. Inject., l. c.

exist. Children bear a much larger proportional amount than adults. Women are much more susceptible than men. Persons having a light complexion are much more easily influenced by it than those having a dark complexion. A delicate female, having light blue eyes and flaxen hair, possesses, according to my observation, the maximum susceptibility. For such subjects two minims of my solution, or $\frac{1}{120}$ of a grain, is a sufficient dose to commence with, and even this amount may occasion severe symptoms. To produce a curative effect in many severe cases of neuralgia, *e.g.* sciatica, much larger doses than I have recommended may be necessary. It will rarely be required, however, to inject more than $\frac{1}{24}$ of a grain at one time.

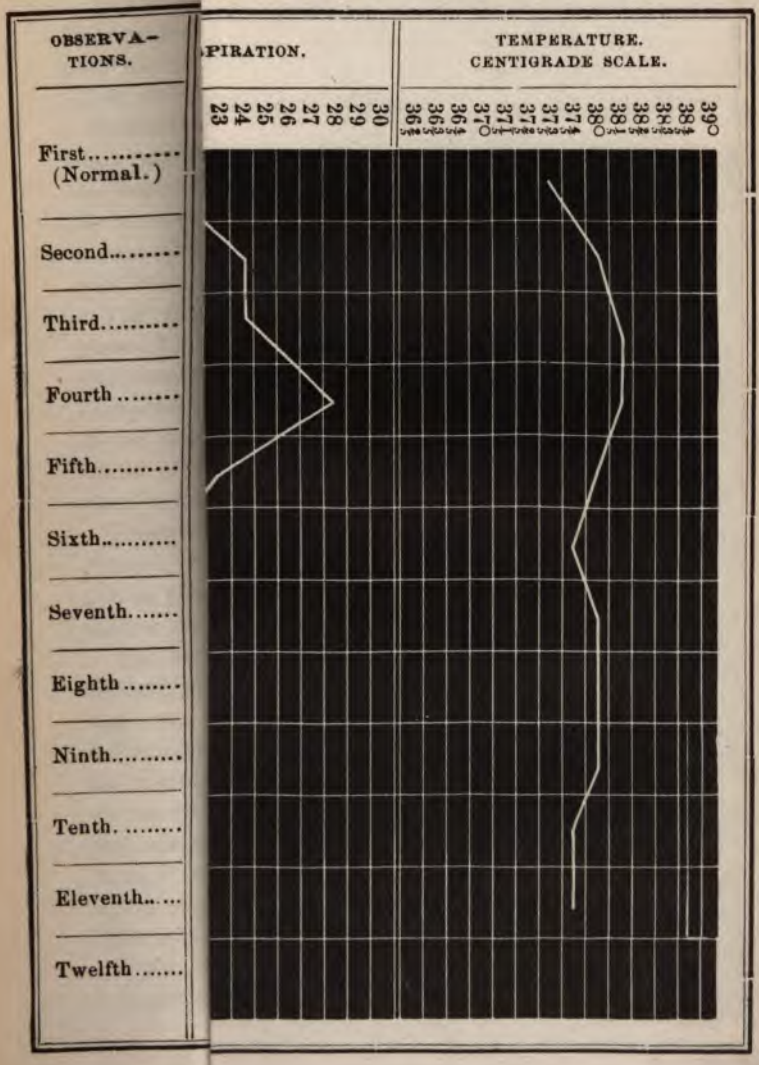
PHYSIOLOGICAL EFFECTS.—The local symptoms at the point of puncture are the same as those I have described for morphia.

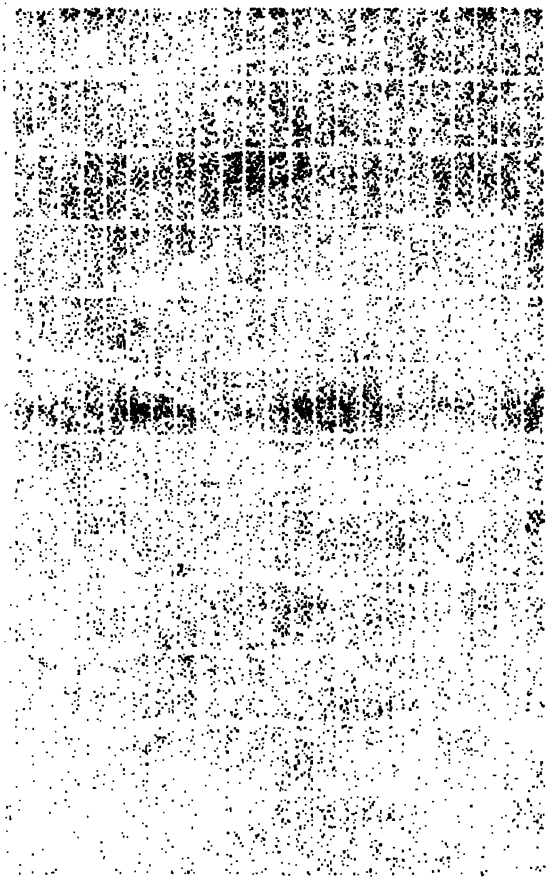
A peculiar dryness and pallor of the lower lip is the first systemic effect to be observed. The dryness quickly invades the mucous membrane of the mouth, fauces, and larynx, rendering deglutition somewhat difficult, and the voice husky. At the same time the pupil begins to dilate, reaching its maximum dilatation in about thirty minutes. With the dilatation of the pupil there occur also deranged accommodation—the vision being presbyopic—and dimness of vision, the outlines of objects being blurred and indistinct. Flushing of the face, more or less deep according to the temperament of the patient, fullness of the head with supraorbital pain and sense of distention, and giddiness, are now experienced. With the development of these effects we observe increased action of the heart

and rise in the bodily temperature. The pulse rises in a few minutes to nearly twice the normal number of beats, and the thermometer exhibits elevation of temperature; but the correspondence between pulse rate and temperature characteristic of fever does not exist. In the annexed diagram the influence of atropia upon the pulse and respiration movements, and upon the temperature, is exhibited. I subjoin also a sphygmographic tracing showing the influence of atropia on the arterial tension. This must be compared with the first tracing on page 44, which is the normal tracing of Dr. Drake, upon whom the observation was made.

At this period the subjective sensations of the patient, as well as the objective phenomena, are those of fever: the skin is hot and burning, and dry; the pulse full and bounding; the face flushed; the eyes injected; the head aches; the ears ring; the mouth is dry and hot; the voluntary movements are disordered in consequence of the vertigo and of the impairment of the muscular sensibility; objects appear confused, and distances cannot be correctly appreciated; hallucinations and illusions occur; when sleep takes place it is disturbed by vivid dreams, sometimes frightful, sometimes pleasing, the patient awaking and holding conversation with imaginary persons. Sometimes a somnambulistic state is produced, in which the patient walks about as

Observ[illegible]ighth of a grain of sulphate of atropia.





if engaged in his usual avocations, talks with the objects of his visions, and quarrels and struggles with those who would oppose and restrain him.

Sometimes the face and forehead are of a vivid red hue, resembling in color the eruption of scarlatina; the fauces are also red and injected, and, to complete the resemblance to this eruptive fever, a whitish fur covers the tongue, through which the red and enlarged papillæ project.

The dryness of the mouth, after some hours, is replaced by a moist condition, in which a viscid, sticky, and somewhat odorous secretion makes its appearance. Corresponding to this change in the mucous membrane of the mouth, some increase in the peristaltic movements of the intestines is to be observed, the evacuations being somewhat loose.

Frequent desire to evacuate the bladder is now experienced, with diminished power, the emission of urine taking place slowly and with difficulty, and sometimes, indeed, only after repeated efforts does the flow occur.

The mental effects, generally such as I have described, are sometimes of a character to awaken grave anxiety. Great depression of mind, a melancholic state, with a suicidal tendency, at night horrible dreams and visions, leading to acts of violence, have been noted by me in some exceptional cases. I mention this so that the reader will ascertain what peculiar mental effects, if any, have followed the atropia injection, and avoid repeating it if the sensations above described have been experienced by the patient.

Such, in general, are the effects produced by the hypodermic injection of a full medicinal dose. These

effects continue about twenty hours; the dilatation of the pupil, the disorders of vision, and the slowness and difficulty of micturition, being the last symptoms to disappear.

Atropia cannot be considered very actively toxic. The symptoms which it produces afford ample warning of danger before the life of the individual is really placed in jeopardy. The sensations which accompany the full manifestations of its physiological effects are so unpleasant that the patient early seeks relief, and the symptoms are so characteristic that a mistaken diagnosis is hardly possible.

When a fatal dose is received, all of the effects which I have described exist in an exaggerated degree. The pulse finally becomes small and thready, the action of the heart weak, and coldness of the surface succeeds to the unnatural warmth. This change in the symptoms indicates that the "irritability" of the organic muscular fibre is exhausted.

In order to a thorough comprehension of its therapeutical action, we must form some exact notions of the mode in which these physiological effects are produced.*

The facts to be investigated are these:

The dilatation of the pupil.

The dryness of the mouth (arrest of secretion).

The increased action of the heart and lungs.

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* I have examined this whole question in my Prize Essay of the National Medical Association for 1869, on Atropia, its Physiological Effects and Therapeutical Uses, to which the reader is referred for full information.

The rise of body-heat.

The influence on sensibility and motility.

Several opinions have prevailed as to the mechanism by which the dilatation of the pupil is accomplished.

This act, as well as the presbyopia, is now known to be produced through the influence of atropia on the organic muscular fibre. By contraction of the radiating fibres of the iris, which are innervated by the sympathetic, the pupil dilates; by a similar action on the muscle of accommodation, the lens is elongated, its diameter diminished, and the subject becomes presbyopic. It is probable, also, that this effect is facilitated by the paralyzing action of atropia on the oculo-motor nerve.

A number of experiments have been made to determine the character of the influence exerted by atropia upon the heart and lungs. The part that paralysis of the pneumogastric plays, the part that direct stimulation of the cardiac portion of the sympathetic takes, in the production of the phenomena, have been earnestly discussed. The inhibiting influence of the pneumogastric on the action of the heart is well understood: if the terminal filaments of this nerve are paralyzed the action of the heart increases. It has been found, however, by Lemattre,* that the action of the heart is increased by atropia, notwithstanding division of the pneumogastric: this agent must, therefore, exert an immediate stimulant action on the cardiac ganglia of the sympathetic. This same effect is witnessed on the organic muscular fibre of the arterioles, as demonstrated

* Archives Générales, 1864.

blood to the cord, the hypodermic injection of atropia ought to be very serviceable in myelitis. But it is now known that the increased action of the heart, and the greater arterial tension produced by atropia, favor hyperæmia of these parts.

The hypodermic injection of atropia is serviceable in certain cases of *delirium tremens*. The indications for its use are these:

Obstinate insomnia, with great restlessness.

Weakened action of the heart; coldness of the surface; clammy sweat.

Failure of nutrients, bromide of potassium, chloral, and hypodermic injections of morphia, to quiet the delirium and induce sleep.

In similar conditions in the *psychical disorders* the subcutaneous injection of atropia is serviceable. This method of treating these disorders has the sanction of the eminent authority of Graefe. My own observation entitles me to insist on this caution: the use of atropia is unsuited to cases in which there is hyperæmia of the nervous centres, or in cases of excitement with power. Moreover, it is not suited to cases of melancholia, for the reason, already stated, that in many persons it produces great despondency of mind.

Atropia cannot be considered a *hypnotic* in the true sense of that term. It is sometimes said to produce this effect indirectly; by allaying pain, it is believed to render sleep possible. This, in the opinion of the author, is not a correct statement of the ground of its utility in certain cases. It is sometimes very useful as a hypnotic in cases of wakefulness and coma-vigil, dependent upon cerebral anæmia.

Neuralgia.—The subcutaneous injection of atropia is not as effective in the treatment of the neuralgias in general as morphia by the same method. The systemic effects of atropia are also more unpleasant. For these reasons morphia is generally preferred. Nevertheless, when morphia fails to produce the desired result, or disagrees with the patient, as is sometimes the case, atropia may be used. In certain neuralgias, it must be admitted also, atropia is to be preferred to morphia, *e.g.* in pelvic pain, in which Dr. Anstie considers it superior to morphia, in sciatica, and in certain cases of *tic douloureux*. In the pain of the various forms of *dysmenorrhœa*, in *ovarian neuralgia*, and in the pelvic pain experienced a few days after delivery, and due to the pressure of the womb on certain nerves, atropia by subcutaneous injection is most serviceable.

The principal triumphs of atropia over neuralgia have been in cases of *sciatica*. It is now admitted that atropia is one of the best remedies for this disease. First proposed and used by Mr. Hunter, it was afterward employed by Béhier, Courty, Oppolzer, Lorent, and others. It has been found, however, that distant injection, and even injection into the subcutaneous tissue of the affected thigh, do not produce such good results as throwing the fluid deeply into the neighborhood of the affected nerve. More frequently, indeed, than in any other form of neuralgia, except the most obstinate and protracted cases of tic douloureux, the nerve itself, or its sheath, has undergone structural alteration; the limb is often diminished in size, its temperature and sensibility lowered, and the power of

its muscles impaired. Under these circumstances, more advantage is to be derived from local than from distant injection, just as Luton, Bertin, and Ruppaner have cured such cases by the injection of irritants into the affected parts.

In severe cases of sciatica and tic douloureux one-twenty-fifth of a grain of sulphate of atropia may be injected; but it should not be forgotten that this quantity will excite very severe symptoms in susceptible subjects. Generally, five minims of my solution, or one-forty-eighth of a grain, will produce decided atropinism. Cessation of the pain is not immediate upon the systemic effects, as Mr. Hunter originally pointed out; indeed, the pain is often at first increased, but improvement takes place after a variable interval, and is often more permanent than after the morphia injection.

Tetanus and Hydrophobia.—In tetanus, atropia has been used in numerous cases, but without success. Recovery has undoubtedly occurred in certain chronic cases, and in idiopathic tetanus; but it does not appear that the result was fairly attributable to the subcutaneous injection of atropia. Within the sphere of my observation, it has been freely used in cases of tetanus and hydrophobia, but without permanent benefit.

Epilepsy.—Brown-Séquard proposed the subcutaneous use of atropia in epilepsy, but he combined it with morphia. Erlenmeyer used it, but with a negative result. My own experience with atropia in this disease is as combined with morphia. The subcutaneous injection of atropia may be employed, instead of the internal use of belladonna, on the method of

Trousseau;* but there are other plans of treatment superior to this.

Diseases of the Respiratory and Circulatory Organs.

The subcutaneous injection of atropia is applicable to the treatment of certain neuroses of the thoracic viscera.

Asthma.—Courty was the first to employ atropia subcutaneously for the relief of asthma. He injected the solution over the pneumogastric nerve. Belladonna, in large doses, is now held to be the best remedy by Hyde Salter, Prof. Sée, and others.† Prof. Sée recommends belladonna because it is a "vascular and cardiac" agent, and "because the means of modifying respiration is to be found in the power to alter the pulmonary circulation." The hypodermic injection of atropia is preferable to the internal use of belladonna, for the following reasons:

The effect is more speedy and certain.

The relief which it affords is greater and more lasting.

In my experience cases of emphysema and spasmodic breathing, due to dilatation of the right cavities of the heart, are not so much benefited by atropia as asthma. I think it prudent to add a caution here: as atropia exhausts the irritability of the sympathetic ganglia, it is not proper to push the use of this agent in cases in which the muscular tissue of the heart is weakened by dilatation or fatty degeneration.

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* Clinique Médicale, tome ii.

† The Practitioner, July, 1869.

In order to procure the greatest relief to the asthmatic paroxysm, the injection should be made promptly at the beginning of the attack. The dose will vary from $\frac{1}{96}$ to $\frac{1}{48}$ of a grain. It may be inserted at any convenient situation. Succeeding attacks should be anticipated if possible, the injection being made when the first warnings are felt by the patient. As the effect of the atropine injection reaches its maximum in about a half-hour, it will at this time be perceived whether a sufficient quantity has been administered.

This method of administering belladonna is much to be preferred to the stomach administration, or to the methods of fumigation, pulverization, or inhalation, notwithstanding fumigation is strongly urged by Prof. Sée* in a late utterance on the subject of asthma.

Harley†—influenced by the fact that great increase of the heart's action follows the administration of atropia, a fact, indeed, previously much insisted on by V. Bezold—recommends this agent as a cardiac stimulant in conditions of great depression of this organ. It is certainly exceedingly useful in those restraint neuroses in which the inhibitive action is exerted through the pneumogastric, for by paralyzing the terminal filaments of this nerve and stimulating the cardiac ganglia of the sympathetic, the action of the heart is quickly improved and the depression overcome. It is in this action, according to Prof. Sée, that we have an explanation of the utility of atropia in asthma.

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* Bulletin Général de Thérapeutique, 15 Août, 1869.

† Gulstonian Lectures, also Vegetable Neurotics.

Diseases of the Digestive Apparatus.

Atropia, it will be remembered, first arrests secretions of the intestinal mucous membrane, but in the reaction which ensues from this state increased secretion takes place. It promotes peristaltic movements by its action on the circular fibres of the intestinal tube.

Vomiting.—Sea-sickness and the vomiting of pregnancy are both relieved by subcutaneous injection of a small quantity—$\frac{1}{200}$ to $\frac{1}{120}$—of a grain of atropia. It may be injected over the epigastrium.

Colic.—The various forms of colic may be relieved by this agent, but it is not so effective in most of them as morphia. It is adapted to cases of colic dependent upon constipation or upon lead poisoning, but the most desirable results are obtained by the conjoined administration of morphia and atropia.

Diseases of the Urinary and Genital Organs.

For all varieties of pelvic pain, as Dr. Anstie has informed us, the subcutaneous injection of atropia is the best agent. I need not repeat here what has already been said on this topic.

Bladder Diseases.—In *dysuria* and *enuresis* it is often most effectual. Belladonna has long had a deserved pre-eminence in the treatment of nocturnal incontinence of urine. Atropia by subcutaneous injection is the most effective way of administering it.

Irritation of the bladder, when arising from a nervous erythism, may be relieved in the same way. That troublesome disorder—*spermatorrhœa*—is most suc-

lence. Both relieve pain, but this effect is much more decidedly the property of morphia. Both produce disorders of motility, staggering, difficulty of co-ordinating muscular movements, vertigo, confusion of mind, and headache. When given together, these effects are curiously modified.

Morphia corrects the hallucinations and phantasms of atropia.

Atropia in small doses—$\frac{1}{96}$ of a grain—increases the hypnotic power of morphia; but if the quantity of atropia be sufficient, it overpowers the effects of morphia on the cerebrum, causing wakefulness or disturbed sleep, phantasms, and illusions.

The pain-relieving power of morphia is increased by atropia.

The disorders of motility, and the vertigo, are not diminished when the two agents are used together, but the after-headache and confusion of mind are much less.

When toxic doses are used, the narcotism of morphia is overcome by atropia, and *vice versa.* In a case which occurred to myself, and which I have already referred to, serious symptoms produced by 1 grain of morphia were relieved by $\frac{1}{24}$ of a grain of atropia. As, however, the effects of atropia are much more prolonged than morphia, it is not easy to exactly counterbalance the effects of one by the other. The cases of morphia poisoning, in which atropia was used as an antidote, that have fallen under my observation, received too much atropia, the toxic symptoms of the latter remaining long after the narcotism of the morphia had disappeared.

cyanic acid. In my prize essay on atropia I have shown that hydrocyanic acid in toxic doses acts too speedily for atropia to influence the result, and that animals fully under the effects of atropia are quickly poisoned by an ordinary toxic dose of the acid.

Upon the organic nervous system these agents seem exactly to antagonize each other.

Morphia produces contraction of the pupil, and a tetanic condition, according to Graefe, of the muscle of accommodation; atropia produces dilatation of the pupil, and contraction of the ciliary muscle. When used together, these effects may be precisely balanced. It takes, however, but a minute quantity of atropia to overcome the action of morphia on the pupil. When these effects on the pupil are balanced, it does not follow that the muscle of accommodation is in a condition to act in a normal manner, for visual defects frequently remain.

Morphia and atropia antagonize each other's action on organic muscular fibre. Morphia prevents the contraction of the arterioles produced by atropia, and, as a consequence of this action, prevents the subsequent relaxation of the muscular fibre. They antagonize each other, therefore, as respects their action on the arterial tension.

2. *On Circulation and Respiration.*—Morphia depresses the action of the heart; atropia is a powerful cardiac stimulant. Morphia produces pallor of the surface, and reduces the external temperature; atropia causes redness and injection of the skin and elevation of the body-heat. The extent to which they modify each other's action is well exhibited in the annexed diagram. It will be seen that the antagonism between them does not extend to the respiratory function; for, whilst morphia administered alone depressed the respiration from 17 to 12 per minute, morphia and atropia combined reduced the number from 18 to 10. When

Dr. De Courcy received the morphia alone, he experienced much less soporific effect than when both agents were injected together; and to this quiescent state of the cerebral functions is to be attributed the slower respiratory movements. The morphia exercises a marked influence over the increase of body-heat produced by atropia. Notwithstanding this, the flushing of the face and the strong subjective sense of heat are experienced by the patient almost as fully when morphia is administered with atropia, as when atropia is given alone.

In the experiment represented on the diagram, the quantity of atropia was not sufficient to produce the full degree of antagonism, otherwise the pulse-line would have continued on the same place. In so far as the atropia influence preponderates, a progressive rise in the pulse-rate is noted.

3. *On the Digestive Apparatus.*—As regards dryness of the mucous membrane of the mouth, fauces, larynx, etc., there is no antagonism, but both agents produce this state and exalt it when administered together. Morphia tends to produce constipation; atropia relaxes the bowels. When administered together, they produce almost immediately intestinal movements, frequently borborygmi, and sometimes sharp pain, and the bowels are kept in a soluble state. The sickness and nausea, and the not uncommon great depression of the vital powers caused by morphia, are opposed by atropia. These agents may therefore be given together in cases in which morphia cannot be borne alone. The after stomachal effects of morphia—indigestion, loss of appetite, a pasty tongue—are much

diminished by the atropia, but are not absolutely prevented. Atropia itself is capable of producing these stomach disorders when used in considerable doses; hence, to produce the result which I have described, the proportion of morphia and atropia should be as folows:

Morphia, $\frac{1}{4}$ of a grain;

Atropia, $\frac{1}{120}$ of a grain.

4. *On the Genito-urinary Organs.*—These agents are antagonistic as to their effects on the kidneys and the urinary excretion. Morphia suspends, and atropia promotes, the functional activity of the kidneys. By inducing congestion of the Malpighian tufts, and increasing the *vis a tergo*, atropia acts as a diuretic, and with the additional water there strains off from the blood the larger amount of urates produced in the more rapid metamorphosis of tissue. Morphia increases the action of the sudoriparous glands, and atropia diminishes it, thereby in the one case lowering, in the other case exalting, the functional activity of the kidneys.

Both produce dysuria, but this result comes of a different action in each case. Morphia impairs the contractile power of the muscular coat of the bladder, so that it contracts with difficulty, the emission of urine taking place slowly; atropia maintains steady tonic contraction of the sphincter, so that it dilates slowly under the voluntary effort, when the desire to micturate is experienced.

Morphia impairs but slightly, atropia to a considerable extent, the sexual appetite; both diminish the ejaculatory effort.

THERAPY.—It would be a waste of space to repeat

the therapeutical applications of morphia and atropia already given with considerable fullness in the preceding sections. Nevertheless, it is necessary to indicate the circumstances requiring or permitting their conjoined administration. A general rule may be formulated as follows:

Whenever the hypodermic injection of morphia is proper and necessary, atropia should be combined with it, unless contraindicated.

In the *psychical disorders*, in which power is in excess, the conjunctivæ injected, the temperature high, morphia should be used alone. When power is deficient, the tendency being to depression, atropia should be combined with it. This is the rule, also, for other *affections of the brain* in which the subcutaneous injection is indicated.

For the relief of *insomnia*, or to procure sleep, the combination of morphia and atropia is to be preferred. The reader should not forget that an excess of atropia, or an amount of atropia sufficient to antagonize the cerebral effects of the morphia, will prevent sleep. They should be used in the proportion of $\frac{1}{120}$ to $\frac{1}{96}$ of atropia to $\frac{1}{4}$ grain or $\frac{1}{2}$ grain of morphia. As the susceptibility to atropia varies immensely, the precise quantity to be employed in any case must be regulated accordingly.

In the treatment hypodermically of the *various convulsive disorders*, morphia and atropia should be combined.

The *neuralgias* are best treated by the combined morphia and atropia solution. There are several reasons for this:

Much larger doses of morphia may in this way be injected without danger to the patient; and the larger the quantity, as Brown-Séquard has shown, the greater the curative power.

Morphia and atropia combined are more effective than either singly.

The systemic effects during the time of maximum narcosis, and also after the narcosis has disappeared, are much less unpleasant and depressing when the two agents are combined than when morphia is used alone.

Sometimes atropia is better borne than morphia, and *vice versa:* in this case the agent whose effects are least unpleasant should be in excess.

In *sciatica* atropia is often more effective than morphia: the proportions in which they should be used are as follows: $\frac{1}{48}$ to $\frac{1}{120}$ of a grain of atropia, $\frac{1}{4}$ to $\frac{1}{2}$ grain of morphia: here the physiological effects of atropia predominate, but the toxic effects are guarded by the morphia.

In *neuroses of the respiratory and circulatory organs* morphia and atropia should be used together. This is especially the case in *angina pectoris* and *asthma*, with the caution I have already given as to the use of atropia in certain diseases of the heart. Morphia alone is to be preferred in *pleuritis*.

In the *diseases of the digestive apparatus*, requiring hypodermic medication, morphia and atropia should be used together.

As a general rule, in *diseases of the urinary and genital organs*, the two agents should be combined. For some purposes atropia should be in excess, as in

good, no danger is to be apprehended from *sleep* merely.

Atropia, relatively considered, does not equal morphia in toxic activity. Severe physiological effects do not necessarily imply a condition in which life is endangered. It is to be remembered that the toxic effects of atropia endure much longer than those of morphia, and hence repeated applications of the physiological antidote may be required.

the objections of Harley and the results of experiments on animals by Brown-Séquard, that the physiological antagonism of morphia and atropia has been amply demonstrated by cases of poisoning occurring in man.

In treating cases, the difficulty of precisely regulating the amount necessary to overcome the toxic symptoms is not easily surmountable. I ascertained, in the case which occurred to myself, that one-twenty-fourth of a grain of atropia was equal in toxic power to one grain of morphia. The state of the pupil affords valuable, but not unerring indications; atropia possesses more power, relatively, over the movements of the iris than morphia.

In a case of morphia poisoning, subcutaneous injection of atropia should produce the following results:

Dilatation of the pupil.

Flushing of the face succeeding to pallor.

Dryness and warmth of the skin succeeding to a cold and clammy sweat.

Rise in the pulse-rate and temperature.

Return of reflex movements of eyelids and fauces.

The dilatation of the pupil should be slightly maintained, and should not be carried to the exaggerated degree sometimes thought necessary. The mistake should not be made of confounding the sopor produced by morphia and atropia with morphia coma. This caution is the more necessary because this sleep is often considered a condition of danger requiring renewed administration of the antidote, and the patient is at length poisoned by atropia. Sufficient atropia should be administered to maintain the action of the heart and the respiration. So long as these continue

alkaloids, are spoiled by the development of a *penicillum*, but this takes place only after long standing and exposure to the air.

Dose.—As is the case with other alkaloids, authorities differ very much as to the quantity of strychnia proper for a hypodermic injection. Lorent employed from $\frac{1}{25}$ to $\frac{1}{10}$ of a grain of nitrate and muriate. Courty and Eulenberg have used so much as $\frac{1}{8}$ of a grain at a dose. These large doses are apt to produce trismus and opisthotonos. The doses used by Hunter varied from $\frac{1}{50}$ to $\frac{1}{24}$ of a grain. Dr. Echeverria, of New York, injected, in the cases of paralysis treated by him, $\frac{1}{60}$ to $\frac{1}{30}$ of a grain—the latter dose producing in the patient, a boy, toxic symptoms. I have injected $\frac{1}{24}$ of a grain. This has seemed to me the maximum quantity which can be used with a proper regard to the safety of the patient. Generally in adults I inject 5 minims of my solution, or $\frac{1}{48}$ of a grain.

Physiological Effects.—When injected under the skin, a sensation of heat and smarting persists for some time in the part. The skin also becomes red in the neighborhood of the puncture; a subjective sensation of warmth is perceived in the limb, and an actual rise in temperature may be noted. At the same time erection of the hair-follicles (*cutis anserina*) takes place.

In a few seconds pain or distention is felt in the abdomen, intestinal movements and loud borborygmi occur, just as is the case so frequently after the hypodermic injection of the narcotic alkaloids. Next the pupils dilate, deep-seated pain and throbbing are felt in the brain, and an unpleasant giddiness renders

the erect posture painful, and standing or walking uncertain. Ringing in the ears, detonation, anxiety, a feeling of dread and flashes of light before the eyes, are also quite commonly experienced. The countenance of the patient affords some indication of the cerebral disturbance, appearing anxious and distressed.

The foregoing symptoms are more severe if larger doses be administered, and in addition there occurs some stiffness of the jaws, jerking of the extensor muscles, and sharp pains like electric shocks shooting through the limbs. Dr. Echeverria has so well described the toxic symptoms that I transcribe his account. My own observations supply no further experiences than those I have just detailed.

"I injected first the right thigh, and about two minutes after, the left. In two minutes more the boy commenced to sigh, and have a meaningless smile, with stiffness in the jaws, soon passing into real trismus. The pupils were largely dilated, the face congested, and tetanic spasms of the respiratory and cervical muscles followed. Every attempt to articulate a word awoke a spasm. He could neither speak nor be touched without being seized with a jerk, and the whole surface of the body was in a perspiration."* In another case Dr. Echeverria had similar experiences. He thus describes them: "In about eight minutes she complained of giddiness, and was soon seized with trismus and opisthotonos. The tetanic spasms were not violent,

* Treatment of Paralysis by Hypodermic Injections of Strychnine. Medical Communications of the Connecticut State Medical Society, 1868.

and were accompanied by general perspiration, congestion of the face, and enlargement of the pupil." Other important observations were made by Dr. Echeverria. "The temperature of the limbs was always raised after the injection. The frequency of the pulse was also augmented. The capillary circulation was rendered more active in the limbs, exhibiting large red patches, more intense in the vicinity of the punctured region. This condition would last three and even four days after the operation. The injections were attended with perspiration of the head and limbs, more profuse with the girl than with the boy. The pupils were always dilated, and gurgling of the bowels would persist some minutes after the puncture. Another very perceptible result was the fibrillar contractions, or twitching of the muscles in the limbs, lasting for a minute or two, and which I have found prolonged for more than an hour in other similar cases."

When we come to analyze the symptoms produced by the subcutaneous injection of strychnia, we perceive that the action is exerted chiefly on the nervous systems of animal and organic life.

Dr Echeverria, from whose able paper I have just quoted, makes much of the effects on the organic nervous system, to support his peculiar views of the nature and causes of certain forms of paralysis. These effects are the following:

The dilatation of the pupil.

The intestinal movements.

The sweating.

The rise in temperature of the paralyzed parts into which the injection has been inserted.

There are no differences of opinion as to the action of strychnia on the nervous system of animal life; but the special seat of the action is much disputed about. It would be of little service to occupy space with these different opinions; it will suffice to state that Schroeder Van Der Kolk has demonstrated in a conclusive way that it acts on the medulla oblongata, the alterations of this organ consisting in a dilatation of its minute vessels. The morbid state of the reflex faculty is a product, then, of the altered nutrition of this part of the cord.

In addition to these remote effects of the injection consecutive to absorption, it is important to note certain local effects of a special kind, of great importance from the point of view of the therapeutical action of strychnia in paralytic affections. Dr. Echeverria has called attention to the "fibrillar contractions, or twitchings of the muscles in the limbs" into which the strychnia injection has been thrown. I have witnessed this very satisfactorily in the course of some experiments with atropia and strychnia simultaneously injected. If a mixed atropia and strychnia injection be thrown under the skin of a cat, dilatation of the pupil will quickly occur, followed by violent twitching of the muscles in the neighborhood of the injection, and thence propagated to all the voluntary muscles.

THERAPY.—The hypodermic use of strychnia is based upon the physiological action of that agent, and I consider its therapeutical application from this point of view.

In Paralysis.—Dr. Béhier, of Paris, appears to have been the first to use the hypodermic injection of strych-

and were accompanied by general perspiration, congestion of the face, and enlargement of the pupil." Other important observations were made by Dr. Echeverria. "The temperature of the limbs was always raised after the injection. The frequency of the pulse was also augmented. The capillary circulation was rendered more active in the limbs, exhibiting large red patches more intense in the vicinity of the punctured region This condition would last three and even four days after the operation. The injections were attended with perspiration of the head and limbs, more profuse with the girl than with the boy. The pupils were always dilated, and gurgling of the bowels would persist some minutes after the puncture. Another very perceptible result was the fibrillar contractions, or twitching of the muscles in the limbs, lasting for a minute or two, a which I have found prolonged for more than an hour in other similar cases."

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The rise in temperature of the paralyzed parts to which the injection has been inserted.

cases for treatment by this method. Nevertheless, the hypodermic injection of strychnia, in many cases, is decidedly curative. As Dr. Echeverria has well remarked, "the effects of strychnia are widely different when administered hypodermically or by the mouth. By the latter method the quantity may be repeated and increased, unsuccessfully, as manifested in the cases of Hunter, and in those here related; and yet a smaller dose of the substance, exhibited hypodermically, be capable of regenerating at once the lost muscular power."

We should possess clear notions, then, as to the circumstances in which it may be proper to use the hypodermic injection of strychnia in hemiplegia, for, manifestly, a remedy of such power may prove to be as harmful when indiscreetly used as it is unquestionably useful in suitable cases.

It is contraindicated in recent hemiplegia.

In my own experience it has not been useful in old cases characterized by contractions of the palsied limbs, for this condition signifies, according to Todd, who styles it "late rigidity," an irritative action about the site of the extravasation.

It has been exceedingly useful in old cases of hemiplegia in subjects not very advanced in life, the paralysis being partial as to motility, and the limbs not wasted.

The hypodermic injection of strychnia has been used in *spinal paraplegia* by Béhier, Courty, Ruppaner, Hunter, Echeverria, and others, with success. The rules for its administration are similar to those I have given for hemiplegia.

It is not proper in acute cases involving structural alterations of the spinal cord.

In cases of paraplegia due to softening or tumor in the spinal canal it will do harm.

It will be beneficial in cases of reflex paraplegia, in paraplegia due to anæmia of the cord, in hysterical paraplegia, and in those cases of paresis of the muscles of the inferior extremities due to concussion of the cord, but after the acute symptoms have subsided.

It is certainly true, however, that Mr. Hunter obtained advantage from it in a case the symptoms of which indicated myelitis. Dr. Echeverria's Case I. may be classed in the same category,—the patient complaining of formication and numbness, and being paralyzed both as to motion and sensation.

The hypodermic injection of strychnia has proved an exceedingly valuable adjunct to the treatment of *infantile paralysis*. If the electro-muscular contractility to the continuous or induced current be not lost, very beneficial results may be expected from this treatment. The injection promotes the capillary circulation, and increases the growth and power of the muscles.

In various *local paralyses* the hypodermic injection of strychnia is even more decidedly curative. Courty* cured *facial paralysis* by injecting strychnia over the course of the facial nerve. Pletzer, Lorent, Sacmann, and Eulenberg had good results from the same treatment.† In a case of paralysis of the vocal cords with aphonia, Neudörfer failed, but in a similar case Waldenburg succeeded with the strychnia injection.

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* Eulenberg, p. 248. † Ibid.

In the "drop wrist" of lead poisoning—*paralysis of the extensors*—it is a very important addition to the other means of treatment of this very obstinate affection. It is more successful than any other agent in *writer's cramp.* Palsy of single muscles or groups of muscles, following cold or rheumatism, is generally curable by this means. The injection also increases much the contractile power in cases of palsy following injury of nerve trunks.

Paralysis of the bladder, with dribbling of urine, and *paralysis of the sphincter ani* not due to myelitis, are much benefited and frequently cured by this means.

In *progressive muscular atrophy* it has been used with great advantage in cases in which the electro-muscular contractility was not lost.

In paralysis of cerebral or spinal origin, without wasting of the muscles, the injection may be made under the skin. The dose of strychnia will vary, with the age of the subject, from $\frac{1}{60}$ to $\frac{1}{10}$ of a grain. In local paralyses, in infantile paralysis, in progressive muscular atrophy, the injection must be made into the affected muscles. If the electro-contractility be not lost, the following effects may be expected:

Rise in temperature of the limb, and increase of capillary circulation.

Increase in muscular power with growth of muscles.

Cure of the paralysis.

If, however, the electro-muscular contractility is lost, fatty degeneration has so far proceeded that the injection of strychnia will be useless.

The method of practicing the injection into the muscles is as follows:

The affected muscle or group of muscles is grasped with the left hand and made prominent, and with the right the needle is plunged quickly and boldly into the muscular tissue. When inserted as far as necessary, withdraw the needle a short distance and inject slowly. It is important, of course, to avoid the blood-vessels, and to insert the needle into the paralyzed muscles. The pain of this operation is not greater than the subcutaneous injection, and little danger of deep-seated abscess is to be feared. Muscular tissue, as is well known, does not readily take on the morbid action called inflammatory. The systemic effects do not follow so quickly nor are they as powerful after injection into the muscular tissue as after the subcutaneous injection. Both local and systemic effects are produced; but it is chiefly the local effects which are desired in cases of local paralysis. Some cases of local paralysis of the bladder cannot be reached in this way. In paralysis of the sphincter ani the needle may readily be thrust into this muscle.

The subcutaneous injection of strychnia has been used in *progressive locomotor ataxia*, but with a negative result. In my own experience I have observed no decided influence for good or evil.

Neuralgia.—The hypodermic injection of strychnia has been used by Dr. Anstie in *gastralgia* and *cardiac neuralgia*, with advantage. "My decided opinion is, at present," says Dr. Anstie, "that there is no such remedy for gastralgia as strychnia, subcutaneously injected in doses of $\frac{1}{120}$ to $\frac{1}{60}$ of a grain." Although I cannot speak so positively as Dr. Anstie on this subject, I can say that I have observed good effects from

the strychnia injection in the class of cases to which he refers.

Amaurosis and Amblyopia.—According to Eulenberg, Fremineau was the first to employ the hypodermic injection of strychnia for the cure of a case of amaurosis following typhus. Sacmann soon after reported a cure of amaurosis by the same means, and Spaeth one of amblyopia,—"functional paralysis of the retina." Dr. Lacerda,* of Lisbon, employed the hypodermic injection of strychnia with success in a case of "amaurotic amblyopia." Talko, of Tiflis,† also succeeded in curing amblyopia by repeated injections, ranging in strength from $\frac{1}{40}$ to $\frac{1}{4}$ of a grain. The most important contributions to our knowledge of this subject have been made by Prof. Nagel, of Tübingen, who, reports cures of amblyopia and amaurosis, and even cases of the latter in which there was white atrophy of the optic disks.‡

As a Tonic.—I have used the subcutanous injection of strychnia to overcome the depression caused by the withdrawal of morphia. It has also given much relief in cases of violent nausea and vomiting produced by the morphia injection.

Treatment of Strychnia Poisoning.—As accidents may happen in the use of strychnia by subcutaneous

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* Gazett. de Lisboa, xi., 1867, and Schmidt's Jahrbücher der gesammten Medicin, vol. cxliii. p. 67.

† Ibid., vol. cxlv. p. 74.

‡ Berliner klinische Wochenschrift, viii. p. 6, 1871. Also, Dr. Nagel's special treatise, which, however, I have not had the opportunity to consult.

injection, it is well to be prepared with the best measures for relief. For the toxic symptoms which occurred in his cases, Dr. Echeverria employed the inhalation of ether, and a turpentine clyster. The elaborate experiments of Dr. Fraser with Calabar bean have shown that we possess in this agent a complete physiological antagonist to strychnia. The physician who uses toxic doses of strychnia against paralysis should be provided with a solution of the extract, or of eserine, the active principle. In the absence of this, the inhalation of ether, employed successfully by Echeverria, should be used. No reliance can be placed on the subcutaneous injection of atropia, for, as I have experimentally shown, this is not a physiological antagonist to strychnia; atropia does not abolish the reflex faculty in animals poisoned by it,—a fact affirmed by Lemattre and verified by myself. It should not therefore, as done by Gubler,* be included among the physiological antagonists of strychnia. To the antidotes or antagonists of strychnia must be added chloral, which, as has been shown by Liebreich, exerts an action physiologically antagonistic.

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* Commentaires Thérapeutiques du Codex Medicamentarius, p. 599. Paris, Bailliere, 1868.

V.

CONIA.

THE SOLUTION AND DOSE.—The formula of Eulenberg is as follows:

℞.—Coniæ, gr. ss;
Spiriti, ʒss;
Aquæ dest. ʒiss. M.

Five minims of this represent one-forty-eighth of a grain. In preparing this solution, the conia should be first dissolved in the spirit, as it is insoluble in water. It is volatile, and exceedingly liable to decomposition, being converted into ammonia and a resin. For these reasons the solution should be prepared for use when required.

The dose will range from $\frac{1}{120}$ to $\frac{1}{60}$ of a grain: 2 to 4 minims of the solution above given.

PHYSIOLOGICAL EFFECTS.—The local effects of the injection are the same as those of other alkaloids. In the largest dose which can be safely administered, it induces sleepiness, vertigo, coldness of the surface, diminished sensibility, and weakness of the inferior extremities. The respiration becomes slower, and less full. The pulse diminishes in number and force, falling so much as thirty to forty beats per minute.

In a case of poisoning carefully observed by Dr.

Bennett,* weakness of the legs, and staggering were first noticed. Loss of all power of voluntary movement next followed. He became unable to swallow, and completely lost his power of vision. "His pulse and breathing were perfectly natural," but at the expiration of a half-hour after this, paralysis of the muscles of respiration had taken place, the action of the heart continuing but was "very feeble." Meantime his intelligence was preserved, but he was without power of articulation.

The mode in which conia produces these effects has been elaborately examined by Kölliker and Guttman. The last-named observer has shown that conia does not act on the spinal cord, nor does it destroy the irritability of muscle, but paralyzes the peripheral terminations of the motor nerves. Death is produced by asphyxia—paralysis of the muscles of respiration—and not by cessation of the heart's movements, for these continue after respiration has ceased.

THERAPY.—The therapeutical applications of conia by the hypodermic method are neither numerous nor important.

It has been used in the treatment of *asthma* by Pletzer. Although it appears to be a rational remedy, paralyzes the muscles of respiration, and in this way may be supposed to antagonize that condition of things which exists in asthma, experience is not in its favor, and a careful examination of its physiological effects discloses the fact that the influence which it exerts on respiration is a toxic action only. In the treatment

* Clinical Medicine, p. 413, Am. ed.

of asthma it is not at all equal to morphia and atropia; nevertheless, in cases in which these agents disagree, or in which it is undesirable to use them, it may be tried.

Erlenmeyer procured relief, by the hypodermic injection of conia, to the difficult breathing of *emphysema.* The same authority reports having cured a case of *angina pectoris* by two injections of conia. He therefore recommends it in these affections.

Lorent, influenced by theoretical considerations,—the action of conia on the pulse and respiration,—has employed this agent hypodermically in pneumonia and pleuritis, with the effect to reduce decidedly the pulse-rate. It does not appear that this treatment is worthy of serious consideration. In the spasmodic affections of the thoracic viscera, Lorent has had experiences with conia similar to those of Erlenmeyer.

Conia is also one of the numerous remedies proposed for the cure of *tetanus.* Successful cases have been reported, cured by conium administered internally; but we may be permitted to distrust these, since Harley has shown that the extract is entirely devoid of conia, and therefore innocuous. For the treatment of tetanus, the hypodermic injection of conia may be used with a reasonable expectation of benefiting the patient.

As conia produces motor paralysis, it has been held to be *antagonist to strychnia;* but since it has been shown by Guttman that conia paralyzes the peripheral terminations of the motor nerves, and does not act upon the cord, this view must be abandoned.

VI.

WOORARA.

THE physiological effects of woorara are similar to those of conia. It paralyzes the motor nerves, commencing at the periphery, and produces death by asphyxia, without affecting the action of the heart.

These physiological effects, determined by Bernard, Kölliker, Kühne, and others, have led to its use in certain disorders of the nervous system in which the reflex faculty is abnormally excited. When the first publications were made, setting forth its peculiar action, very confident hopes were entertained that a specific for *tetanus* had been discovered. It failed in the hands of Follin, Gintrac, Cornoz, and Richard, and was successful in the hands of Gherini, Demme, Lochner, and Spencer Wells.* In most of the successful cases it was used endermically as well as hypodermically. Of twelve cases treated by the hypodermic injection, four terminated favorably. According to the statistics of Demme, of twenty-two cases treated by woorara, administered in either mode, eight recovered. Prof. Busch treated eleven cases of tetanus by woorara, and six recovered; but, as the professor thinks this agent is adapted only to the more chronic cases, our estimate

* Kulenberg, op. cit.

of its value must not be too high, for chronic cases often terminate in recovery under the most diverse methods of treatment.

In the successful cases, large doses of woorara were administered. Spencer Wells injected one-twelfth of a grain at a dose. The dose ranges from one-sixtieth to one-thirtieth of a grain. The frequency of administration will be governed by the effects upon the spasms.

Woorara has also been used in *epilepsy*, in *convulsive tic*, in *strychnia poisoning*, but without sufficient success to justify its employment in this class of cases. It does not bear the relation of a physiological antagonist to strychnia, and hence should not be used against the toxic symptoms caused by this agent.

VII.

NICOTIA.

The Solution and Dose.—Erlenmeyer recommends the following formula:*

℞.—Nicotiæ gr. ss:
Aquæ destil. ʒij. M.

Four drops (minims) of this contain one-sixtieth of a grain,—a suitable dose.

Physiological Effects.—Nicotia is one of the most deadly poisons, ranking in this respect with prussic acid. In its local action it is somewhat irritant. In its remote or systemic action it strongly depresses the nervous and vascular systems. At first respiration is slightly accelerated, and is accompanied by a bruit, produced, according to Bernard, by a very abrupt contraction of the diaphragm. Slowness and feebleness of respiration soon succeed to this acceleration. The pupils dilate, and convulsive phenomena make their appearance in the eyes and extremities, partly of a clonic, and partly of a tonic or tetanic character. Complete adynamia supervenes, accompanied by muscular trembling; the action of the heart becomes exceedingly

* Die subcutanen Injectionen, op. cit., p. 85.

feeble, and death takes place by failure of the circulation (paralysis of the heart).*

THERAPY.—Nicotia has been employed with success in the treatment of *tetanus*. About one-half of the traumatic cases treated with it get well,—a proportion of recoveries greater than with any other remedy except physostigma.

Prof. Houghton, of Dublin, who was probably the first to employ this agent in tetanus, ascertained experimentally that it is a physiological antagonist to strychnia.

Nicotia is indicated in *spasmodic asthma*, certain cases of *angina pectoris*, *colic*, *strangulated hernia*, etc., but I know of no instance in which it has been used for the relief of these conditions.

Cases of obstinate *convulsive tic*, "*histrionic spasm*," and local *muscular spasm* are of a nature, theoretically speaking, to be benefited by the subcutaneous injection of nicotia.

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* Gubler, Commentaires du Codex Méd., op. cit., p. 347.

VIII.

HYDROCYANIC ACID.

THE SOLUTION AND DOSE.—The *Acidum Hydrocyanicum Dilutum* of the U. S. Pharmacopœia is the preparation which I have employed for hypodermic use. The maximum quantity which I have used is four minims, but this amount is hardly safe in many cases. It should not be forgotten that the action of hydrocyanic acid is so rapid that a toxic dose introduced under the skin would infallibly destroy life before any measures could be employed for relief. For ordinary purposes, two minims of the officinal solution will be sufficient for hypodermic use. As its effects are quickly expended, it may be repeated frequently.

PHYSIOLOGICAL EFFECTS.—Locally, the effects are somewhat irritant, but are not more so than a solution of morphia. A metallic taste, slight salivation, faint nausea, giddiness, and sighing respiration are the only systemic effects which I have observed from the doses I ventured to administer.

THERAPY.—The good effects sometimes produced in *mental disorders* by prussic acid, when administered by the stomach, are more conspicuously exhibited when the remedy is injected under the skin.* It is

* McLeod, Medical Times and Gazette, March, 1863.

adapted to acute cases, in which power is in excess. Cases of mania or melancholia, in which the subcutaneous injection of morphia proves hurtful, are benefited by prussic acid, and *vice versa.*

I have used hydrocyanic acid hypodermically in spasmodic asthma, but without moderating the paroxysms. It is indicated in *angina pectoris*, and other cardiac neuroses, but I am not aware of any instances in which it has been tried.

As a remedy for *gastralgia* when a simple neurosis of the stomach, it is undoubtedly useful. In *nausea* and *vomiting* due to functional disturbance, and especially those cases in which morphia and atropia disagree, it may be used with a confident expectation of affording relief. But, as a general practice, the subcutaneous injection of prussic acid in those stomach disorders is, in respect to promptness and efficiency, greatly inferior to morphia and atropia.

The injection may be practiced over the epigastrium in cases of vomiting.

W. Preyer,* who has carefully investigated the physiological action of prussic acid, affirms that atropia is a physiological antidote. His researches have conducted him to the conclusions that prussic acid acts by depriving the blood of its oxygen, and that in very large doses it paralyzes the heart. He considers atropia the antagonist to this action by maintaining the action of the heart. I have carefully repeated the experiments of Preyer, and am unable to confirm

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* The Practitioner, vol. i. p. 106.

them.* I find that animals (cats) fully under the influence of atropia are speedily destroyed by poisonous doses of prussic acid,—just as speedily, indeed, as if atropia had not been administered. If administered simultaneously, or atropia soon after prussic acid, the result is the same.

* Prize Essay of American Medical Association, for 1869, on Atropia.

IX.

PHYSOSTIGMA.

THE SOLUTION AND DOSE.—The following formula may be used:

℞.—Ext. physostigmæ, gr. ij;
Aquæ destil. ʒi.
M. Filter.

Ten minims of this solution contain $\frac{1}{3}$ of a grain, a sufficient quantity to commence with. As Dr. Fraser remarks,* arbitrary rules for the dosage cannot be laid down. As the solution of the extract has an acid reaction and produces irritation of the tissues, it should be neutralized by carbonate of soda.

The alkaloid *eserine* may also be used, but as it is an unstable preparation the extract should be preferred. I have used, in some investigations of my own, an alkaloid prepared by Merck of Darmstadt, to which he affixed the name "calabarin." Although this has the properties of physostigma, it cannot be considered a pure alkaloid.

The solution of the extract should be prepared when it is needed, since it decomposes after a time.

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* The Practitioner, vol. i. p. 85.

quency of the pulse (rarely the reverse), with tendency to syncope, pallor and lividity of the face.

The action of ergot is chiefly expended on the organic nervous system. According to Brown-Séquard, by causing contraction of the muscular fibre of the arterioles, it produces anæmia of the nervous centres. If this be the correct view, the toxic phenomena referrible to the nervous system of animal life are consecutive, and not due to the direct action of the agent on the brain and cord. This view is probably too exclusive.

The hypodermic injection of ergotin, in suitable doses, will not cause the symptoms of acute ergotism above described, but a knowledge of the symptoms which may be looked for when it is desired to push the remedy is necessary in order to avoid ill results.

THERAPY.—The hypodermic injection of ergotin is indicated when prompt contractions of the uterus are required, as in *post partum* hemorrhage.

Some very important results have lately been obtained by Langenbeck* in the treatment of *aneurism*. Recognizing the action of ergot in promoting the contractions of organic muscular fibre, Prof. Langenbeck bethought himself that this same action might be usefully applied in the treatment of aneurism. His first experience was in a case of subclavian aneurism. He injected thirty grains of ergotin (aqueous extract) in the space of forty days, which procured great relief, diminishing the size of the tumor, and the pain and paralysis of the arm and hand. A radial aneurism

* Berliner klinische Wochenschrift, No. 2, 1869.

was quickly cured by the same means, viz., the injection under the skin, over the tumor, of a solution of aqueous extract of ergot.

Profuse and alarming *epistaxis, hemorrhage* in cases of the hemorrhagic diathesis, *hæmoptysis, hæmatemesis,* and *metrorrhagia* are conditions of disease in which the subcutaneous injection of ergot proves of great utility.

Dr. Reuben, of Hamburg, reported in 1869* two cases of menorrhagia cured by this method. In 1870, Dr. Landmann † gave the details of a case of metrorrhagia which was quickly relieved in the same way. In the same year Dr. v. Swiderski‡ published a memoir containing a number of cases of chronic metritis, subinvolution, metrorrhagia, menorrhagia, treated successfully by the hypodermic injection of ergotin. The most remarkable application of this agent is that successfully employed by Prof. Hildebrandt in the treatment of uterine fibroids. Nine cases were subjected to this treatment, in which the results are thus stated by the author of the treatment:

"One tumor of very large size, reaching above the navel, has been completely removed. A second, which extended to the right costal border, and filled the whole abdominal cavity, has been so far reduced that its fundus stands below the navel. In four other cases very marked diminution has been attained, and the

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* Deutsche Klinik, xxxii., 1869.

† Schmidt's Jahrbücher der gesammten Medicin, vol. cxlviii. p. 301.

‡ Berliner klinische Wochenschrift, Dec. 12 and 19, 1872.

presumption is safe, judging from past experience, that a continuance of the treatment would have led to perfect cure had not the patients withdrawn themselves from what must, of course, be admitted as a tedious kind of treatment. Of great significance is the total disappearance of those tormenting symptoms,—the profuse hemorrhages, the debilitating serous discharges, and in all cases the harassing pains."* Hildebrandt advises inserting the injection about the navel.

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* Berliner klinische Wochenschrift, 17th June, 1872.

XII

QUINIA.

THE SOLUTION AND DOSE.—The solution for subcutaneous use which I have recommended* is the following:

℞.—Quiniæ sulphat. ʒi;
Acid. sulph. dil ♏xl;
Aquæ destil. ʒi. M.

This should be carefully filtered, to separate any particles of undissolved quinia or foreign matter. From 15 to 30 minims of this is a sufficient dose. It should be injected into a place where the areolar tissue is abundant. If a larger quantity than 30 minims be necessary, it were better to insert in two places. As ether is a good solvent of the alkaloid *quinia*, the following may be used:

℞.—Quiniæ, gr. viij;
Ether, ʒi. M.

Or, shake together any convenient quantity of quinia (the alkaloid) and ether; one part of the former will be taken up by sixty parts of the latter. The ether being allowed to evaporate spontaneously, a solution may be obtained, finally, of one part of quinia to six parts of ether. This solution is in some respects ob-

* Russell Prize Essay on Quinine.

jectionable; the rapid evaporation of the ether leaves the quinia an adhesive mass, which occludes the syringe and makes the injection difficult and uncertain.

PHYSIOLOGICAL EFFECTS.—The solutions of quinine, when injected beneath the skin, excite considerable burning and a zone of more or less intense redness for some distance around the puncture. If care be not used in the preparation of the solution, inflammation will follow at the site of the puncture, matter will form, and possibly a diffuse inflammation of the areolar tissue will ensue. Before I had learned the necessity for caution, accidents of this kind occurred in my own hands, and lately some very bad cases have been reported as occurring at New Orleans, where, it is said, a *mixture* of quinia sulphate and water was injected under the skin.

Very slight systemic effects follow the subcutaneous injection of quinia. They are similar in character to those produced by the stomach administration, and, as they are so well known, require no description here.

THERAPY.—"Dr. Chasseaud published, in 1862, an account of the great success which he had obtained in the treatment of *malarial fevers*, in the hospital at Smyrna, by the subcutaneous injection of quinine. He ascertained that this agent, administered in this way, had a more decidedly curative power, without occasioning its usual physiological effects, than when given by the stomach. This practice has since been continued with undiminished success at the same hospital by Dr. J. McCraith."* Dr. Moore, of the Bombay

* Extracted from my Prize Essay on Quinine.

Medical Service, repeating these experiences, concludes "that four or five grains of quinine injected beneath the integument are equal to five or six times that amount taken into the stomach."

Not only is the immediate therapeutic effect of the quinine given in this way greater, but more permanent cures thereby result. In one hundred and fifty cases treated in this way, Dr. Chasseaud had but a single relapse. Such has been my own observation.

From three to five grains, injected under the skin, will suffice to cure an ordinary intermittent. Fevers of the remittent type, and pernicious fevers, will require a larger amount. In those deadly malarial attacks, known as *pernicious*, is the efficacy of this treatment most conspicuous. Much depends, as everybody knows, upon bringing the patient promptly under the quinine influence; the subcutaneous injection is the quickest and most powerful means of accomplishing this object.

Recent malarial fevers may be aborted at the beginning of the cold stage by a full injection, but it is better to anticipate the attack by an hour or two, in order to procure the physiological effects, before the onset of the expected paroxysm. It is true that the injection may be administered at any time during the febrile movement, but it is better to anticipate and prevent it. The ultimate cure will depend upon the amount of quinia received by the patient, and not upon the period at which it was administered.

The subcutaneous injection is much more effective also against *chronic malarial poisoning* than the stomach administration, but here we meet with new

conditions, requiring other management than the use of quinine. We may confidently expect to prevent the febrile movements by frequent repetition of the injection; but we do not thereby cure the disease, for the changes induced by the long-continued action of malaria, in the liver, spleen, gastro-intestinal mucous membrane, cerebro-spinal axis, must be corrected if we would arrest the objective phenomena of fever and cure the patient.

Dr. Eulenberg sums up his conclusions in regard to the cases in which the subcutaneous injection of quinia in malarial fevers may be desirable, as follows:

In intermittents complicated with gastric disorder.

In children in whom the disagreeable taste and the large doses necessary produce strong aversion and stomach derangement.

In poor and hospital practice, where economy in the use of the drug is desirable.

These conclusions seem to the writer well founded. But he has omitted chronic malarial poisoning, in which the subcutaneous injection of quinia has undoubted utility.

The hypodermic use of quinia has been extended to various diseases,—fevers, neuralgia, angina pectoris, strychnia poisoning, etc.,—but without advantage over existing methods of treatment.

NOTE.—Dr. Tessier, in the Mauritius, for the cure of intermittents injects under the skin a solution of *carbolic acid*, ¾ of a grain to 20 minims of water. He reports that the patients were rapidly cured!—*Lond. Chem. News*, July, 1869.

XIII.

MERCURY.

THE SOLUTION AND DOSE.—Applying the rules given in Part I., I reject all insoluble preparations of mercury. Scarenzio* used in 1864 a mixture of calomel, glycerine, and water. Hebra† injected a solution of sublimate—gr. i to ʒss aq. Hill, of England, made use of a solution of sublimate containing $\frac{1}{6}$ of a grain to the dose. Lewin,‡ who first submitted this practice to systematic examination, employed a weak solution of corrosive sublimate. The following is a suitable formula for hypodermic injection of mercury:

℞.—Hydrarg. chlor. corrosiv. gr. i;
Aquæ destil. ʒi. M.

Ten minims of this contain $\frac{1}{48}$ of a grain. As Lewin, and especially Liégeois, have shown that concentrated solutions are not desirable and that large doses are not necessary, this formula will be strong enough for ordinary purposes. Recognizing the fact that indura-

* Eulenberg, op. cit., p. 307.

† Ibid. Also, Bulletin de Thérapeutique, vol. i., 1869, p. 297. De l'Application de la Méthode hypodermique au Traitement de la Syphilis par les Preparations mercurielles. Par le Dr. F. Bricheteau. Ibid., vol. ii., 1869, p. 158, by M. Liégeois.

‡ Ibid.

tion of the tissue, and frequently unhealthy and sloughing ulcers, were produced by these injections of sublimate, Bricheteau requested M. Bouilhon, a Paris pharmaceutist, to prepare a salt of mercury soluble and free from irritant properties. M. Bouilhon suggested the double iodide of mercury and sodium as supplying the conditions required.

℞.—Hydrarg. et sodii iodid. gr xxiv;
Aquæ destil. ℥iij. M.

Fifteen minims of this contain $\frac{1}{4}$ of a grain. Ten minims or $\frac{1}{6}$ of a grain will generally be sufficient for an injection. "This salt," says M. Bouilhon, "fulfills perfectly the object; it introduces into the economy only the active substance combined with a small quantity of a salt of sodia." But as this salt is difficult to prepare and as the corrosive chloride is more readily procured, the latter will generally be employed. With suitable precautions, abscess will not frequently result from its use. Thus, Lewin,—who used his solution, which is stronger than that I have recommended,—many hundred times, found small abscesses to occur in the proportion only of two to three for one hundred injections.

The formula of M. Liégeois,* whose very important memoir has just appeared, is as follows:

℞.—Hydrarg. chlor. corrosiv. gr. iij;
Morphiæ sulph. gr. iss;
Aquæ destil. ℥iij. M.

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* Bulletin Général de Thérapeutique, 30 Août. 1869. p. 158.

Fifteen minims of this solution contain $\frac{1}{82}$ of a grain, the quantity recommended by Liégeois for a single injection. It will be perceived that this solution contains the same quantity of sublimate as the formula I have proposed, but only about one-third of that used by Lewin. In two cases only has Liégeois observed abscess and eschar follow his injection. This comparative immunity from ill effects is to be attributed, unquestionably, to the small proportion of sublimate. The injection is preferably inserted under the skin of the back.

PHYSIOLOGICAL EFFECTS.—The injection of the corrosive chloride is accompanied by severe burning pain and considerable local heat and redness. If the solution be concentrated it will produce induration of the areolar tissue, inflammation and abscess, and sometimes a dry eschar, leaving an ulcer slow to heal. The intensity and persistence of the pain will depend upon the quantity of sublimate injected; weak solutions do not occasion much distress; the pain of any solution may be much mitigated by the conjoined use of morphia, as in the solution of Liégeois.

Salivation is frequently produced, according to Lewin, who had fifty-one cases of mercurial stomatitis in one hundred and forty-four men treated in this way. On the other hand, Liégeois found salivation an "exceptional" occurrence, there being only four in one hundred and ninety-six subjects, and these were mild cases. The difference in result here is plainly due to the difference in the strength of the respective solutions. It is a curious and important circumstance, that this physiological effect has no relation to the

therapeutical results in syphilis, for Liégeois' cures are even more numerous proportionally than Lewin's.

The subcutaneous injection of sublimate does not impair any of the functions, but increases the activity of the digestion and assimilation, so that decided increase in weight takes place in most of the cases in which it is employed.

THERAPY.—The therapeutical applications of mercury by the hypodermic method are confined to the treatment of syphilis, in which results of the greatest value have been obtained.

It is applied to the treatment of primary (infecting chancre), secondary (constitutional), and tertiary forms of this disease. I have used it with great advantage in the tertiary, but have not had the opportunity to give it sufficiently numerous and prolonged trials to enable me to pronounce as to its utility in primary and secondary syphilis. I therefore avail myself of the very full reports and statistical evidence published by George Lewin, of Berlin, and M. Liégeois, of Paris. The following are the statistics of Lewin:

"Cases* treated exclusively by injections of sublimate, 107; relapses 24, or 22 in 100.

"Cases treated by injections of sublimate, after sarsaparilla decoction and sweating, 58; relapses 19, or 30 in 100.

"Cases treated simultaneously by injections of sublimate, sarsaparilla decoction, and sweating, 24; relapses 7, or 33 in 100.

* These statistics are based upon cases of constitutional syphilis.

"Cases treated by injections of [illegible] of potassium, 50; relapses [illegible].

"Cases treated by [illegible] of potassium, 60; [illegible].

To sum up—356 patients [illegible] injections of sublimate [illegible] treated; the relapses have [illegible].

With the ordinary [illegible] are 81 in 100 cases.*

The conclusions [illegible] his large observations [illegible]

1. The syphilitic [illegible] with a rapidity [illegible] mate daily injected.

2. Certainty [illegible] tained by nine months [illegible] years and a half.

3. Lessened [illegible] occur are light.

4. Facility [illegible]

The statistics [illegible] Thus, of 196 [illegible] by injections [illegible] were ameliorated [illegible] jections were [illegible] ber of relapses [illegible] in 100; [illegible] 100). The [illegible]

[illegible]

creased length of time required by Liégeois' method as compared with Lewin's, are due to the small quantity injected, but these disadvantages are more than counterbalanced by the greater proportional number of cures. The production of salivation, then, is unnecessary in order to secure the best results from the hypodermic injection of mercury. The longer the constitutional symptoms have existed, the greater the number of injections required to effect a cure.

In practicing the injection, the back should be selected for the site of the puncture. Two injections, of 8 minims each, may be practiced at one sitting, one on each side. This quantity should be inserted daily. If the symptoms be not urgent, if time is of little consequence, and if it be desirable to avoid salivation, the daily quantity may be much less.

With the view to avoid the irritation produced by subcutaneous injections of corrosive sublimate in the ordinary way, and also to administer it in larger doses, Dr. Staub conceived the idea of using it in the form of an albuminous solution in alkaline chlorides. He prepared his solution as follows:

Corrosive sublimate, 1 gr. 25.
Chloride of ammonium, 1 gr. 25.
Chloride of sodium, 4 grs. 15.
Water, 1 gr. 25.

After filtration this solution is added to an albuminous solution (white of one egg to 125 parts of water). Twenty drops of this contain 5 milligrammes of sublimate. It produces no irritation when injected under the skin. The results of treatment with this solution

have been very favorable in the hands of M. Staub. He reports 44 observations, the treatment varying from 17 to 34 days, and the amount injected being 1 centigramme daily. He observed no relapses.*

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* Archives Générales de Médecine, Juillet, 1872.

Among the few observations on the subcutaneous injection of arsenic which I have been able to find, are a brief note by Eulenberg on the use of Fowler's solution by Prof. Lehman in a case of "pernicious puerperal fever," and in Reynolds's "System of Medicine." In an article on chorea* in the latter work, Dr. C. B. Radcliffe has presented some interesting facts on this subject, which I subjoin.

"This patient had suffered for nine years with a distressing choreal affection of certain muscles of the neck, by which the head was kept continually turning and bobbing. At different times various modes of treatment had been tried, including the hypodermic injection of morphia and atropia, without the least benefit. . . . The idea of injecting arsenic hypodermically occurred to me on the 12th of January, 1866, and was carried out the same day. Fowler's solution was chosen, and the part selected was the most tender point over the contracting muscle." Commencing with three minims, the quantity injected was finally raised to fourteen minims. "Before the fourth injection was practiced, a marked change for the better had

* Vol. ii. p. 133, et seq.

taken place; before the eighth, the choreal movements were almost at an end, and a change for the better had gone on steadily from the beginning." Dr. Radcliffe reports another case in which amelioration, equally as great, was produced by the hypodermic injection of arsenic, the patient being a lady sixty years of age. He has also employed "with results more or less satisfactory the hypodermic injection of arsenic in certain cases of neuralgia, epilepsy, and other affections of the nervous system."

In the choreal cases above referred to, Dr. Radcliffe's "object in introducing the arsenic hypodermically was not to escape gastric irritation, but to produce some local change in the nerves of the parts which were the seat of the disorder, as well as to bring about some more general change in the system."

Dr. Radcliffe employed for these injections at first the undiluted Fowler's solution, but as considerable local irritation followed he afterward diluted it by one-half water. This proved much less irritant. It is probable, I think, that the *Liquor Sodæ Arseniatis* will be found much better for hypodermic use than Fowler's solution. This being a higher oxide than the arsenite of potassa is less irritant in its local action and less apt to produce arsenical poisoning. Moreover, it is a clear solution, possessed of a considerable degree of osmotic power. The solution of the arseniate of soda may be injected in quantities of five to ten or even fifteen minims. Every alternate day is sufficiently often in ordinary cases to make the injection. It will be found advisable not to insert the solution frequently in the same neighborhood.

M. Lipp* has proposed to use arsenic subcutaneously in cases of psoriasis and chronic eczema. He reports three cases thus treated successfully. He injected from one to two centigrammes of arsenious acid. The general symptoms produced by these injections were elevation of temperature, acceleration of pulse, diminution of appetite, increased thirst and diuresis, nervous excitement, headache, vertigo, cough, redness of conjunctiva, etc. The advantages which M. Lipp claims are, the smallness of the dose, the shorter duration of the treatment, and the absence of injury to the digestive organs.

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* Archiv für Dermatologie und Syphil., No. 3, 1869.

XV.

IRRITANT INJECTIONS.

Dr. Luton,* of Rheims, under the singular designation "parenchymatous substitution," described a method of treating neuralgias, new formations, hypertrophies, etc. This method consists in the injection into the substance of the affected part of such irritants as tincture of iodine, nitrate of silver, chloride of sodium, etc. The term applied to this process was intended to express the theoretical views of its author in regard to the nature of the therapeutical action which takes place. The pain and irritation set up in the part were assumed to be *substituted* for the morbid process.

Dr. Ruppaner imitated this method of Luton in the treatment of sciatica and other neuralgias. Dr. Bertin (de Gray) also, attracted by the results obtained by Luton, practiced the method for several years and then published the results.† I have had myself a limited experience with this method.

The substances employed in this way are chiefly the following:

A solution of iodine.

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* Archives Générales de Médecine, Oct. et Nov. 1863.

† Ibid., Avril, 1868, p. 444.

A saturated solution of common salt.

A solution of the nitrate of silver.

The tincture of cantharides.

The following is the solution of iodine employed by Bertin:

℞.—Potassii iodidi, gr. xv;
Tinct. iodinii, ʒijss;
Aquæ destil. ʒx. M.

The quantity of tincture of iodine may be increased to ʒv.

The tincture of iodine is sometimes employed alone and undiluted.

The following is a suitable formula for the nitrate of silver solution:

℞.—Argenti nitrat. ʒij;
Aquæ destil. ʒi. M.

To illustrate at the same time the class of cases to which this method is applicable, and its therapeutical power, I subjoin the statistics of Bertin:

1.	Tumors formed by development of the thyroid gland	8
	Cured	5
	Ameliorated	1
	Failed	2
2	Lymphatic ganglions	8
	Cured	8
3.	Bursæ	1
	Cured	1
4.	Neuralgias	7
	Old sciaticas treated by injection of nitrate of silver	2

Cured	2
Old sciaticas treated by solution of common salt	2
Cured	0
Recent sciaticas treated by solution of common salt	2
Ameliorated	2
Recent sciaticas treated by injection of nitrate of silver	1
Cured	1

Ruppaner employed the nitrate of silver injection in one case of cervico-brachial neuralgia, and in four cases of sciatica; two cases were ameliorated, and three cases of sciatica were cured.

As respects *neuralgia*, this method of treatment seems specially adapted to cases of sciatica,—obstinate cases in which structural alterations have probably taken place in the neurilemma. In order to be effectual, the injection—five drops of the nitrate of silver solution—should be thrown into the vicinity of the nerve. It produces great pain and burning, and is followed by considerable inflammation, not diffused, but localized to the site of the injection. Abscesses, of course, frequently happen from this practice, and, indeed, sufficient irritation to result in this way seems necessary to produce the best effects. It is probably true that the irritation, and not the agent, is the principal factor in the curative process.

Injections of the iodine solution have been practiced with success in *goitre*. The tincture of iodine may be thrown into the substance of an enlarged thyroid without producing violent irritation. Five minims of

the tincture will be sufficient for this purpose, and it may be repeated every other day. Recent cases are quickly cured by this treatment. I have seen excellent results from the same application in those *cystic and glandular tumors* so frequently found in the cervical region. After evacuating the cyst with a trocar, the tincture of iodine may be freely thrown into the sac, and the solid parts of the tumor injected by the hypodermic syringe, the needle point being well introduced into the substance of the growth.

Enlarged bursæ are best treated by the same means; evacuate the contents and inject the solution of iodine. Slight inflammatory action follows, the tumor becomes indurated, and finally disappears.

Solid tumors may be destroyed by injecting such irritants into them as will give rise to violent inflammatory action and sloughing. Into the substance of cancerous new formations, various corrosives may be injected; but this practice, although rational, has not hitherto proved satisfactory,—a remark equally true of Dr. Broadbent's method of injecting dilute acetic acid, —of the success of which such confident expectations were at first entertained.

Recently* considerable success has been claimed for the treatment of tumors by the injection into their intimate structure of *gastric juice*. As this practice is devoid of danger in suitable cases, and as the gastric juice is not difficult to obtain from the stomach of the pig, it is desirable to have further experience in order to form decided opinions as to its utility.

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* Bulletin Général de Thérapeutique, Août 15, 1869.

It would be foreign to my purpose to speak of such uses of the iodine solution as the injection in hydrocele, in hydrothorax and empyema, in cystic disease of the ovary, etc., and of the use of perchloride and persulphate of iron in nævus.

INJECTION OF AMMONIA INTO THE VEINS.—As the hypodermic syringe is the instrument employed in this operation, it may be proper to include in my account of hypodermic medication some references to the injection of ammonia into the veins. We owe to Prof. Halfourd, of Melbourne, Australia, the introduction of this important means of relief. He used it to overcome and remove the lethal effects of the poison of venomous snakes. A number of successful cases have now been reported occurring in the practice of Prof. Halfourd and others. The solution used consists of one part of *aqua ammoniæ fortior* and two parts of distilled water. By means of an ordinary hypodermic syringe this solution is injected into a vein. The quantity is determined by the effect; one or more syringefuls may be injected. Care must be used to prevent the introduction of air. The operation appears to be devoid of danger, and to be free from ulterior bad effects.

The injection of ammonia is indicated not only in the case of poisoning by venomous snakes, but in various conditions in which the danger to life consists in depression of the heart's action. In *poisoning by hydrocyanic acid* it may be used with a good prospect of success. The report of a case of poisoning by chlorodyne has lately come to us from Australia, in which life was saved by the injection of ammonia. In

cases of danger from thrombus of an important vessel, as, for example, thrombus of the pulmonary artery, a cause of sudden death after delivery, this mode of treatment is strongly indicated. In failure of the heart's action during chloroform narcosis, the injection of ammonia should be promptly practiced.

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